Never buy another costly 9V battery!

SILICON CHIP

MARCH 2004
$7.25* INC GST NZ$8.25 INC GST
ISSN 1030-2662 03
PRINT POST APPROVED - PP255003/01272
9 771030 266001
siliconchip.com.au

PROJECTS TO BUILD - SERVICING - COMPUTERS - VINTAGE RADIO - AUTO ELECTRONICS

The revolution in cricket and tennis:

HAWK-EYE
How it Works!

E-S-R METER

FREE!

ALTRONICS CATALOG (Aust only)

USB Flash Disk Drives: all you need to know

Gadget Central

enjoy tomorrow today

The No.1 Destination for all your Gift Purchases

Shocking Novelty Wire Game

Test your skill but beware; if you fail you will receive a mild electric shock.

- Move the tester around the face but don't touch the sides.

$29.95

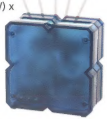
Oscillating Message Board

Gift Ideas

- Displays a message, time, or date
- Mechanism looks invisible while in motion
- Size: 125(H) x 125(W) x 64(D) mm

Was $69.95
Save $10

$59.95



Wireless FM Transmitter

Use your CD/MD/PDA/MP3 player to listen to your favourite tunes through your car FM radio. Attach the portable audio player and tune your car stereo to one of the 4 FM frequency ranges

$34.95

new

Remote Control Combat Tank

Table-top tank battles have now become more exciting with these new remote controlled replica tanks. Get two tanks and engage your opponent in a one-on-one tank battle. 2 models available.

- Dimensions: 75(L) x 45(D) x 40(W)mm (approx.)

new

$44.95 ea

Foosball Table

Great Soccer Fun for Everyone!!

- Includes scorekeeper and two balls
- Sturdy wooden construction
- Play in teams or one-on-one
- Size 950(L) x 520 (W) x 330 (H) mm

$129.00

- Other table top games available

Travel Electric Blanket

Keep warm on long distance car trips with this 12V electric blanket. Made from 100% Terylene fabric, it contains a safe, low voltage heating element. Supplied with a 2.5m lead and cigarette lighter plug.

- Measures 1.5(L) x 1.1(W)m

new

$49.95

Water Spray with Fan

Keep cool in summer with these fans that spray water! Available in small and large sizes.

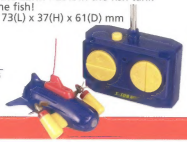
$5.95

$9.95

Remote Control Mini Submarine

The ultimate toy for the bathtub, pool, or fish pond. Full manoeuverability features and fitted with an LED headlight, it can even see in the dark! Put it in the fish tank and chase the fish!

- Measures: 73(L) x 37(H) x 61(D) mm



$29.95

Vibrating Head & Joint Massager

Just the thing for relief after a hard day at work. Provides all over relief to the scalp area and joints in the body.

$19.95

new

Great for the Outdoors

8 Litre Collapsible Bucket

This great 8 litre bucket collapses down to pack away, so it's ideal for camping, hiking or any situation where storage space is an issue.

- Measures 255(W) x 35(H)mm when folded, 255(W) x 230(H)mm when open

new

$14.95

The Ultimate Pocket Knife

Survive the rugged outdoors with this 13-piece pocket knife. Includes pliers, knife, bottle opener, screw driver, scissors, corkscrew and tweezers.

new

$24.95

Headrest with Sunshade

Great for the beach or park, this lightweight headrest is compact and will protect you from the sun's harmful rays. Folds neatly away in a drawstring bag.

new

$14.95

Valid until end March '04

All prices in $A

CHATSWOOD
314 Victoria Ave.
Ph: 02 9884 8822
Open 7 Days

BURWOOD
95 Burwood Rd.
Ph: 02 9744 6022
Open 7 Days

LIVERPOOL
225 Macquarie St.
Ph: 02 9822 7822
Open 7 Days

ERINA
Shop 247a, Erina Fair
Ph: 02 4367 0611
Open 7 days

For the latest Gadget Central flyer, visit www.gadgetcentral.com.au

Contents

Vol.17, No.3; March 2004

SILICON CHIP

www.siliconchip.com.au

FEATURES

7 Hawk-Eye: The Coming Revolution In Sport?
How fair was that LBW decision? Would the ball really have hit the stumps? Was that fast serve in or out? Hawk-Eye removes the doubt – by Ross Tester

16 Transferring PC Data? – Put It On The Bus!
Say goodbye to Zip disks – flash disks are much smaller and more convenient. Just "hot-plug" them into a USB port and you're set to go – by Ross Tester

66 Hands-On PC Board Design For Beginners; Pt.2
Using the basic features of Autotrax and creating a simple PC board design. There's also info on creating your own component libraries – by Peter Smith

76 Review: Escort 3146A Bench Top Multimeter
High-spec unit boasts 5-½ digits – by Peter Smith

PROJECTS TO BUILD

10 QuickBrake: For Increased Driving Safety
Simple project turns your brake lights on faster than you could ever apply them, to reduce rear-end shunts – by Julian Edgar & John Clarke

24 3V To 9V DC-DC Converter
Don't buy expensive, short-lived 9V batteries. This little DC-DC converter is adjustable and lets you use two AA, C or D-size cells instead – by Peter Smith

58 The ESR Meter Mk.2
Forget about capacitance meters; an ESR meter is the way to go when it comes to identifying faulty electros – by Bob Parker

70 Power Supply Demo Design
Simple DC power supply provides a well-regulated output voltage in the range from 1.2V to 37V. And it's all on a small PC board – by Peter Smith

73 White LED Driver
Efficient circuit runs off 12V and drives up to 30 white LEDs. It can even switch on automatically when darkness falls – by Stephen David

78 PICAXE-18X 4-Channel Datalogger; Pt.3
Adding a humidity sensor, more memory and an LCD – by Clive Seager

SPECIAL COLUMNS

34 Circuit Notebook
(1) Signal Meter For Weather Satellite Receiver; (2) Car Battery Failure Detector; (3) Switch Timer For Bathroom Light; (4) Model Theatre Lighting Dimmer; (5) Fully Adjustable Power Supply; (6) 4-Wire Stepper Motor Driver

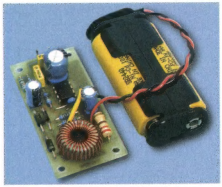
38 Serviceman's Log
It's been a Panasonic month – by the TV Serviceman

82 Vintage Radio
The little 1934 Astor Mickey – by Rodney Champness

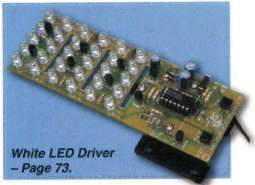
DEPARTMENTS

2 Publisher's Letter
4 Mailbag
55 Product Showcase
57 Silicon Chip Weblink
88 Ask Silicon Chip
92 Order Form
93 Market Centre
95 Ad Index

QuickBrake: For Increased Driving Safety – Page 10.



Adjustable 3V To 9V DC-DC Converter – Page 24.



White LED Driver – Page 73.

ESR Meter Mk.2 – Page 58.

SILICON CHIP

www.siliconchip.com.au

Publisher & Editor-in-Chief
Leo Simpson, B.Bus., FAICD

Production Manager
Greg Swain, B.Sc.(Hons.)

Technical Staff
John Clarke, B.E.(Elec.)
Peter Smith
Ross Tester
Jim Rowe, B.A., B.Sc, VK2ZLO

Reader Services
Ann Jenkinson

Advertising Enquiries
Leo Simpson
Phone (02) 9979 5644
Fax (02) 9979 6503

Regular Contributors
Brendan Akhurst
Rodney Champness, VK3UG
Julian Edgar, Dip.T.(Sec.), B.Ed
Mike Sheriff, B.Sc, VK2YFK
Stan Swan

SILICON CHIP is published 12 times a year by Silicon Chip Publications Pty Ltd. ACN 003 205 490. ABN 49 003 205 490 All material copyright ©. No part of this publication may be reproduced without the written consent of the publisher.

Printing: Hannanprint, Noble Park, Victoria.

Distribution: Network Distribution Company.

Subscription rates: $76.00 per year in Australia. For overseas rates, see the subscription page in this issue.

Editorial & advertising offices:
Unit 8, 101 Darley St,
Mona Vale, NSW 2103.

Postal address: PO Box 139,
Collaroy Beach, NSW 2097.

Phone (02) 9979 5644.

Fax (02) 9979 6503.

E-mail: silchip@siliconchip.com.au

ISSN 1030-2662

* Recommended and maximum price only.

PUBLISHER'S LETTER

We launch SILICON CHIP On-Line

This month, we are officially launching our new website and the on-line version of SILICON CHIP. Some years ago, I wrote an editorial stating my opinion that the Internet was a money vortex and that few companies had made money from their web activities. That is still largely true for many companies so this new venture represents a leap of faith for us. However, the new site has been going since December 2003 and already the indications are favourable.

"SILICON CHIP On-line" is available at our existing website address at **siliconchip.com.au** (no need to type in the "www" bit). There you will find all the issues of SILICON CHIP going back for about two years. As time goes on, we will extend this.

About a week after this print issue goes on sale, you will find the articles also available on-line, together with our other services such as software and PC board downloads, article indexes (features and projects), errata and so on. Soon, you will also be to be subscribe to the print edition and order back copies on-line, as well as purchase books and binders.

Creating and maintaining a website as large as **siliconchip.com.au** and publishing the on-line edition is not a zero-cost exercise. Nor is the production of our regular monthly print edition. Either way, these costs have to be recouped, so the bad news is that this on-line service is not free. In principle, the cost of reading an issue will be the same, whether you read it on your computer screen or buy the print edition issue at your newsagents – or subscribe.

Some articles are available free while with the others you can read the first page and then you have to reach for your credit card to gain access to all the articles in a particular issue. Please have a look at the site and you should it find it pretty easy to follow.

The on-line edition of SILICON CHIP is being produced by Web Publications Pty Ltd, who also produce a number of other on-line magazines. They are pioneers in this area, having produced *Autospeed*, an on-line only car magazine, for five years.

Initial reactions indicate that most of our existing readers will probably prefer the print edition – you can read it at any time (in bed, on the train or bus, wherever) and you can file it away for future reference. On the other hand, for people overseas, those in remote areas and those who want immediate access to magazine issues (rather than waiting for them to come through the mail), the on-line service will be preferred.

By the way, our site is fully searchable so you should be able find any article we have done, providing you feed in the appropriate key word. In fact, feeding the appropriate key word into **www.google.com** will often bring you to the relevant article on **siliconchip.com.au**. Failing that, do a search of our article indexes and you should find what you want (provided we have published it).

So have a good look through the site. If you are a relatively recent convert to SILICON CHIP, you should find many articles that you have not seen before. Eventually, all the articles we have published will be available for access. This is great because it means that a great many articles will no longer be lost and forgotten, as they presently tend to be.

We hope you like our new website and the on-line edition. And if you think some aspect could be improved, don't hesitate to email us.

Leo Simpson

Computer bits? We've got the lot!

LCD Monitor Arm

Holds 14", 15" & 17" LCD monitors. Supports up to 8kg. 3 in 1 design - desktop, wall and clamp mounting. Standard VESA mounts.

Cat 4666

Cat 4666-7 **Monitor Arm** $99

USB Net Phone

This USB connected phone allows free calls across the internet using third party software. Just plug into a USB port, no drivers needed. Operates with NetMeeting, MSN Messenger, Skype etc.

Cat 10129-7 **USB Net Phone** $89

Bluetooth Head Set

Go hands free with your bluetooth phone.

Cat 11907

Cat 11907-7 **Head Set** $199

Bluetooth Serial Cable Replacement

This module is unique! Turn any serial device into a wireless device with this bluetooth adapter for the device end

Cat 11908-7 **Serial Cable Replacement Device** $459

Front Access PC Card Drive

This unit is an ATA Flash card drive which connects to the IDE connector of a standard PC. It reads full size ATA flash cards and supports Win98/ME/2000/XP.

Cat 6668-7 **PC Card Drive Hot Swap** $99

Front Access PCMCIA Drive

This "drive" supports two type I or one Type II card with full PCMCIA compatibility.

Cat 6482

Cat 6482-7 **PCMCIA Drive Front Access** $321

PC CardBus Sockets

Transfer your PC CardBus (32 bit) and PCMCIA (16 bit) based data to your desktop PC. This "drive" has two rear slots and supports Type I, Type II and Type III PC Cards.

Cat 6520

Cat 6523-7 **PC CardBus Drive** $199

USB Smart Card Reader/Writer

The package includes API Library, Demo Program and Demo Source code and is suitable for applications in security control, loyalty programs, EDI, Kiosks, PKI and eCommerce etc.

Cat 8981-7 **Smart Card Reader/Writer - USB** $139

Dual Video Capture Card

An integrated DV (digital video) and AV (analog video) input all-in-1 PCI interface card.

Cat 3529-7 **Two in One - DV and AV** $249

Watch Dog Timer

If your application program locks up, these watch dogs will apply a hardware reset to the computer after a selectable period.

Cat 17070-7 **Watch Dog Timer Card PCI** $332

Cat 17084-7 **USB Auto reset - Watchdog** $199

Touch Screen Overlay for 15in LCD

This touch screen fits over the front of an LCD display and connects to the PS/2 port of a pc. Mouse software drivers are included.

Cat 4353-7 **Monitor Touch Screen PS/2** $699

DVI KVM Switches

A KVM switch to share a DVI monitor, PS/2 keyboard & mouse with two computers.

Cat 11663-7 **2 way DVI PS/2 - KVM Switch** $169

Checkout these great POS Solutions

Cash Drawer

A robust metal construction casing with adjustable dividers for four or five compartments, and a separate coin tray. Compatible with Star, Epson and Citizen POS printers

Cat 8897-7 **Cash Drawer** $199

Pole Displays

These customer displays are designed for POS application and are driven from a serial port.

Cat 8727

Cat 8728-7 **POS customer display 11.2mm** $359

Cat 8907-7 **POS customer display 9mm** $289

POS LCD Monitors

Cat 4658

When space is at a premium these POS displays will do the job. With a resolution of 800 x 600 they connect directly to a VGA output. An integrated touch screen is optionally available.

Cat 4658-7 **12.1" LCD Monitor** $999

Cat 4659-7 **10.4" LCD Monitor** $999

Citizen POS Receipt Printers

These quality Citizen printers offer a reliable solution for the most demanding POS situations. Bi-directional and available in both Serial and Parallel.

Cat 5694-7 **IDP3420 with tear bar - Serial** $479

Cat 5695-7 **IDP3420 with tear bar -Parallel** $479

Cash Registers

Affordable Registers for small retail and speciality stores, with highly visible operator displays.

Cat 1008138

Cat 1008129-7 **Sharp XE-A101** $289

Cat 1008138-7 **Sharp XE-A202** $589

Fast POS Thermal Printer

A very fast thermal printer with extremely easy paper loading. It literally churns out the receipt at 180 mm/s. Comes with a parallel interface. Gray or Black available.

Cat 9177

Cat 9177-7 **POS Thermal Printer** $799

Bar Code Laser Gun

A very competitively priced laser bar code reader with excellent performance - and it looks the part too. It will interface as a keyboard wedge, USB or serial device by simply changing the configuration and the cable.

Cat 1008039

Cat 1008039-7 **Bar Code Laser Gun** $399

Omni-Directional Laser Scanner

Get the same bar code reading capability as the big super markets! An affordable, vertically mounted, small footprint, omni-directional laser scanner. It is ideally suited to checkouts of all types, eg newsagents, convenience stores etc.

Cat1008085

Cat1008085-7 **Omni-Directional Laser Scanner** $999

Opto In Relay Out PCI

Lets your computer receive information and control a large range of external devices even from a remote location.

Cat 17074

Cat 17074-7 **8 CH Opto DI 8 CH Relay Output PCI Dec** $399

Micro Computers/PXE Terminals

Cat 1149

This very small footprint computer measures only 330x280x100 and utilises a standard ITX motherboard

Cat 1149-7 **Micro Footprint PC** $499

For mobile or remote site applications, this computer only needs a 12 Volt supply

Cat 1150-7 **12 Volt Embedded PC** $749

VGA Splitters

These splitter modules enable multiple monitors to share the same information off a host PC simultaneously. The units also boost the VGA signal allowing distances up to 75m from the local machine.

Cat 3070-7 **VGA Splitter 2 way Max Distance 75m** $199

Cat 3055-7 **VGA Splitter 4 way Max Distance 50m** $259

Cat 3056-7 **VGA Splitter 8 way Max Distance 50m** $379

Throw away your old fashioned keys...use RFID

Cat 1009079

RFID (Radio Frequency Identification) is the new contactless way of opening doors, tracking goods, etc.

Cat 1008082-7 **Electrically operated door lock** $189

Cat 1008081-7 **All in one controller & sensor** $349

Cat 1008079-7 **Stand alone controller** $269

Cat 1008080-7 **RFID reader 80mm range** $209

Cat 1008057-7 **RFID reader 200mm range** $269

Cat 1008106-7 **RFID reader RS232 connection** $199

Cat 1008083-7 **RFID card 0.8mm thick** $4.50

Cat 1008058-7 **RFID card 1.8mm thick** $3.25

Cat 1008059-7 **RFID key-tag** $6.50

RFID & Finger Print Readers

Control access to your premises and maintain a record of all comings and goings. Virtually any combination of Keypad PIN, RFID tag and/or fingerprint reader can provide the level of security you choose. Optional access management software allows control via an RS232 or RS485 link to a PC.

Cat 1008142

Cat 1008142-7 **RFID & Finger Print Reader/Controller** $1,999

Cat 1008143-7 **RFID Reader/Controller - LCD Display** $549

Cat 1008145-7 **Access Control Software** $399

Business Card Cutter

Cat 5448

Design, print and cut your own business cards. Our kit consists of Business Card Design Software, 50 sheets of high quality business card paper (500 business cards) and a business card cutting machine.

Cat 5448-7 **Business Card Cutter** $249

Surveillance Equipment

Cat 3499

Keep an eye on things with our range of surveillance equipment.

Cat 3429-7 **4 Camera Input Kit** $899

Cat 3491-7 **Dome Style colour camera** $249

Cat 3489-7 **Dome Style B&W camera** $96

Cat 3496-7 **B&W camera - IR Illumination** $114

IP Addressable Cameras

Run an ethernet connection straight from the camera to monitor your video feeds locally or remotely.

Cat 3487-7 **Cat 5 connected camera** $669

Cat 3475-7 **Wireless camera** $1099

Thin Client Terminals! We've got them for Serial, Ethernet, Windows Based and Linux applications

Dealer inquiries welcome

MicroGram Computers

Ph: (02) 4389 8444 FreeFax: 1800 625 777

info@mgram.com.au

Vamtest Pty Ltd trading as **MicroGram Computers** ABN 60 003 062 100, 1/14 Bon Mace Close, Berkeley Vale NSW 2261

All prices subject to change without notice. For current pricing visit our website. Pictures are indicative only.

See all these products & more on our website...www.mgram.com.au

VOMWSEMDSHRS

MAILBAG

Valve preamp feedback defeats the purpose

I cut my teeth on valve amplifiers and have been repairing them for musicians ever since. Despite that, I totally agree with the last line of your Publisher's Letter in the November issue – if you compare the LM833 with any valve, it's no contest. If you want fidelity, you don't use valves. But I'll leave that debate to others.

What I'm really wondering is who will use your valve preamp design and for what? Instead of a normal opening stating the need or inspiration we have a hint in the editorial about interested experimenters, and at the tail of the article that "guitarists" might be interested in valve sound.

You do concede that valves can still be legitimate electronic components, and you cover valve theory quite well, but why the big back-flip? Valves still have some very useful advantages as input amplifiers such as being almost indestructible by input overvoltage, combined with almost infinite input resistance.

For guitarists, there is a moderate (3-5%) second harmonic distortion caused by the inherent non-linearity of the transfer characteristic (your Fig.3 p26). This is progressive over the signal swing and not to be confused with clipping, soft or otherwise. But your valve preamplifier design very effectively irons that out flat! (Figs.5, 6 & 7).

A Fender "Stratocaster" guitar fed into a Fender "Twin-Reverb" is considered a classic and practical situation. The input stage of valve guitar amplifiers like the "Twin" are, almost without exception, are as shown on the left of your Fig.2 (page 25, November 2003). The only feedback applied is DC from the cathode resistor; no AC feedback at all.

They normally lack the 100pF top-coupling capacitor in the input on the simple reasoning that neither the speakers nor the guitar have much output above about 5kHz. Despite this apparently seriously "nasal" bandwidth, this rig can produce ear-splitting highs.

I'm no "feedback purist". I'm just pointing out that the "classic" (ie, distorted) sound comes from NOT having feedback for linearity.

Roly Roper,
via email.

Valve guitar sound is desirable

I'm writing to congratulate SILICON CHIP for publishing the Valve Preamp project in the November 2003 issue.

I play guitar in a band and have designed and built two all-valve guitar amplifiers, a 2-channel 50W rack-mount monster and a small 4W "combo" amplifier, which I am happy to say were either built using easy to obtain (within Australia) components or salvaged parts from old radios.

I assume that most of the people who will build the valve preamp kit will either fall into the category of musician or hifi enthusiast, and I would like to offer one or two comments.

The idea of "Valve Sound" (at least as far as guitar amplifiers are concerned) is something made up from a number of contributing factors, one of the most important of which is the output transformer. They are big and heavy and a prime source of high harmonic distortion but that's the whole point of that sound! The user *wants* high levels of harmonic distortion and the perceived warmth of valves is due to high levels of second and third harmonic distortion, which in a tube guitar amplifier is desirable.

Coupled with a high gain preamp (three or more triode stages) and a pentode or triode output stage (push-pull configuration is the most common), this creates the overall valve sound that many guitarists will shell out megabucks to obtain.

Also, in regard to Leo Simpson's comments about the prohibitive cost of a 60W all valve guitar amp/speaker kit, a price of around $1000 is peanuts compared to something similar available commercially. A quick scan through some of my mail order music catalogs reveals prices floating around $1800 - $3500 for a 60W guitar amplifier.

I would hazard to guess that there would be quite a few readers willing to part with $1000 to obtain a valve guitar amplifier that they could build themselves.

Andrew Curtis,
via email.

Digital TV dropouts

I would like to add a few comments to the current debate about Digital Television. I have owned one of the early Thomson set top box (STB) decoders for quite a while and have recently been given a PC/STB combination unit. Both perform very well with very good picture quality but they both will drop reception when the signal is not quite up to scratch. By not up to scratch, I mean an equivalent analog signal from the same antenna, that can only be described as perfectly adequate, can still produce intermittent dropouts.

Recently I spent a few days at a house in Pacific Palms near Forster, NSW. As I knew the TV reception at that location was marginal and a check on the DVB website indicated the ABC digital transmission was available, I decided to take the small decoder to try it out. The ABC analog transmission is on a VHF-Hi channel and is a little noisy and has some ghosting.

To my surprise, the decoder worked and produced a first-class picture until the dropout problem struck again. The decoder would stop working, sometimes every few seconds. Sometimes it would go for many minutes without dropping out; working consistently it was definitely not! The point I am trying to make is that when analog is switched off, a lot of people will have to invest in satellite TV or have nothing usable. It is thoroughly annoying to watch a perfect digital picture and have the sound drop out frequently.

All this early talk about being able

to watch digital signals in marginal areas, even in a moving car, is absolute rubbish. The signal quality needs to be better than good in my experience. Recently, I walked into an electronics store at Warringah Mall, in Sydney. There are a number of STBs on display there, all working, and guess what – all dropping out every now and then. Things will need to work better when analog is turned off!

Horst Leykam,
via email.

Happy with 12AX7 valve preamp

I've recently completed the 12AX7 valve preamp from the November issue and I am quite delighted with it. I am using it with my wideband audio, double-tuned crystal set tuner for the AM broadcast band. The high input impedance of the valve preamp is ideal for the application and the valve preamp drives the line level input of my transistor power amplifier and speakers.

As suggested in the SILICON CHIP article, this preamp doesn't really have the "warmth" of a typical valve preamp (second harmonic distortion?). However, in comparison with my standard line preamp, using an NE5532 low noise op amp, the valve preamp has a much more "open" sound that is an absolute pleasure to listen to.

Possibly this is due to the typically heavy use of negative feedback in op amp circuitry, compared to the somewhat lesser use of negative feedback in the valve design. Whatever the reason, the preamp sounds very nice.

By the way, in my version, the ferrite-cored transformer hisses quite audibly during operation. Is this normal?

Felix Scerri,
Ingham, Qld.

Comment: the line version of the preamp featured in the February issue would be more appropriate to your application. It is normal to hear some "frizzle" from the step-up transformer.

UHF to VHF converter

In the December 2003 issue (p91), W. B. asked about a UHF-to-VHF converter. I made such a converter some years ago when SBS first started transmitting and my old TV did not have a UHF tuner. I purchased a scrap UHF tuner with a mechanical capacitor tuning circuit. I reduced the capacitance by carefully separating the vanes of the variable capacitor until the output of the mixer was in the VHF range instead of the original UHF tuner IF output. I then connected this new output to the antenna input on my VHF TV and presto – a down-converter which produced a very good picture.

By fiddling with my UHF tuning capacitor modification I was able to get fairly good tracking, allowing me to tune in other UHF community stations and watch them on a spare VHF channel (I think I used Ch. 0 because it would have been the lowest frequency). The whole job was done with no test equipment at all; just a good background in electronic theory, some youthful enthusiasm and some luck. The whole thing (TV, tuner, etc) went in a garage sale many years ago. I wish I had kept it, for sentimental reasons.

Brad Fuller,
via email.

PCB design tutorial

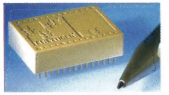
I have read David Jones' tutorial articles on PC board design and I enjoyed them. As someone with a reasonable amount of design experience, I found them a "refresher" course. I do have some comments though.

For information on the silkscreen, component values and/or designators are fine if there is room for them but I find that with tight layout and tiny components, there quite often isn't room to put anything. So one has to prepare separate manufacturing drawings of the PC board showing at least the designators. Even on manufacturing drawings there may not be space to put the component values.

I do disagree with the comment that back annotation is rarely needed. When preparing the net list, all the components have to have a designator. In all but the simplest of boards, you can't know where the components are going to be on the board. So when the board is laid out, the components in terms of an ordered placement against designator are all over the place, which on any reasonable sized board makes hand assembly difficult, as a lot of time is wasted locating the component.

So the re-annotation feature of the PCB package is used to re-assign the component designators in an orderly

The Tiger comes to Australia



The BASIC, Tiny and Economy Tigers are sold in Australia by JED, with W98/NT software and local single board systems.

Tigers are modules running true compiled multi-tasking BASIC in a 16/32 bit core, with typically 512K bytes of FLASH (program and data) memory and 32/128/512 K bytes of RAM. The **Tiny Tiger** has four, 10 bit analog ins, lots of digital I/O, two UARTs, SPI, I²C, 1-wire, RTC and has low cost W98/NT compile, debug and download software.

JED makes four Australian boards with up to 64 screw-terminal I/O, more UARTs & LCD/keyboard support. See JED's www site for data.

TIG505 Single Board Computer

The TIG505 is an Australian SBC using the TCN1/4 or TCN4/4 Tiger processor with 512K FLASH and 128/512K RAM. It has 50 I/O lines, 2 RS232/485 ports, SPI, RTC, LCD, 4 ADC, 4 (opt.) DAC, and DataFLASH memory expansion. Various Xilinx FPGAs can add 3x 32bit quad shaft encoder, X10 or counter/timer functions. See www site for data.

$330 PC-PROM Programmer

This programmer plugs into a PC printer port and reads, writes and edits any 28 or 32-pin PROM. Comes with plug-pack, cable and software. **Also available is a multi-PROM UV eraser with timer, and a 32/32 PLCC converter.**

JED Microprocessors Pty Ltd
173 Boronia Rd, Boronia, Vic. 3155
Ph 03 9762 3588, Fax 03 9762 5499
www.jedmicro.com.au

arrangement, in one of a number of arrangements of increasing rows and columns. Then this new annotation is passed back to the schematics.

Note that the re-annotation may not be perfect. On the program I use, an occasional component will be out of sequence. This happens particularly with resistors and capacitors.

Regarding the choice of PCB file format, anything Protel is certainly fine for local manufacturers. But for overseas manufacturers, it's been my experience that Gerber is the preferred format. At my work, when we get prototype PCBs made locally, we send Gerber files. This acts as a cross-check that the files are correct, as these files will be sent to the overseas manufacturer. It is also an additional protection of intellectual property, as none of the component information appears in the files. This is not to denigrate in any way the integrity of the local manufacturers; it is the old story of not supplying more information than you have to.

Ian Johns,
via email.

Amplifier design philosophy questioned

I have a few unrelated comments about audio amplifiers. I note with some interest your 350W amplifier in the January 2004 issue. One design detail in complementary symmetry amplifiers of this sort has puzzled me for some time. Is it really necessary to have a 10Ω resistor between signal ground and the real DC return earth?

This must surely assume the input to such an amplifier always has a floating ground, which will not necessarily be so. Thus, the output from an external preamp or equaliser of some sort feeding into an amplifier like the Studio 350 is very likely to have a signal earth that is also at DC earth return (usually the chassis or equipment housing). If both pieces of equipment have a mains earth, this will effectively short out your 10Ω resistor. What then?

Your article on the Studio 350 could say more about the choice of output transistors and the considerations that drove this choice. To know this would be of some interest.

I do not understand why three key performance measures are not included in the performance data for amplifiers like the Studio 350. They are: (a) power bandwidth, which is rather more meaningful than small signal (1W) frequency response. After all, a small signal bandwidth from DC to daylight is of little use if the slew rate is poor; (b) intermodulation distortion and transient intermodulation distortion, both of which are perceptually intrusive; and (c) power supply performance under full power tone bursts.

Yes, I've seen the very impressive scope picture but what happens on longer tone bursts at full power? Does it sag? Is the regulation of the supply well damped?

I do not understand the emphasis you place on ultra low harmonic distortion performance. Sure, getting this down to 0.1% or a bit better is important but beyond that, given the distortion levels in signal sources and transducers, could anyone hear the difference? Would it not be better to minimise intermodulation distortion (static and transient)?

On a completely different topic, I am constantly amazed at the extraordinary science fiction written about valve amplifiers. I am forced to conclude that much of it is more about being part of a cult than about pursuing serious engineering science.

Over 40 years ago, I was involved in designing hifi preamps and power amplifiers (see Miniwatt Digest for 1962 or thereabouts) and I still have a very clear view of the real limitations of valve amplifiers – not least the horrible things that happen in output transformers. My colleagues of that era would be astonished at some of the claims being made today! I have even read apparently serious discussions on the web about the big (?) differences in the sound produced by different brands of the same output tube! Give me a break!

Emeritus Professor J. E. Clark,
via email.

Comment: the 10Ω resistor is included in the signal earth return in order to improve the separation between channels when the module is used in a stereo set-up – it reduces the circulating currents which inevitably occur when a stereo source is connected and when both modules are powered from a common power supply. It can be omitted in a mono set-up.

We did not dwell on power transistor choice as it would have made the article a lot longer. But for power output versus cost, the ones we chose are pretty good. There are some bigger power transistors used in Japanese amplifiers but they are harder to get and more costly.

Power bandwidth is more meaningful than frequency response at 1W but far more difficult to measure, particularly if you don't want to overload components in the output filter, not to mention the increased power dissipation in the output transistors themselves. Of course, we also do distortion runs versus frequency at high power but only up to 20kHz and since distortion is always low, slew rate limiting does not come into the picture.

We can easily do intermodulation testing but we have always found that if THD is very low, then so is intermodulation. TID is more difficult to measure but if there is bandwidth limiting at the input, TID should never be a problem. If we were to publish all these tests it would make already large articles much larger.

Longer tone bursts would inevitably lead to sagging as the simple power supply is not particularly well regulated. We do not believe there is much value in really "stiff" power supplies – there is no audible benefit and the cost is much higher.

Partly the emphasis on extremely low THD is because we can! If the THD of bog-standard CD players is as low as .001% (or lower) then ideally the THD of the amplifier should be much less. Yes, the distortion in speakers is going to be much higher but that will not necessarily mask the distortion from amplifiers. Indeed, high order harmonic products from amplifiers can be heard at extremely low levels in quite ordinary loudspeakers.

Our 15W class A design from July 1998 has the lowest THD we have ever measured. It is also the best sounding amplifier we have ever heard – the clarity has to be heard to be appreciated. On that basis alone, we feel justified in always striving for the very best THD performance. **SC**

The Coming Revolution in Sport?

If you've been watching the cricket or tennis on TV this summer, you'll no doubt have seen (and heard of) Hawk-Eye. Just how does this all-seeing, all-knowing electronic "eye" do its thing?

For those who have been too absorbed in the 20th movie repeats of the summer to watch live sport, perhaps a word or two of explanation: Hawk-Eye is an electronic umpire, able to tell (for example) whether a Brett Lee screamer would have hit the stumps had it not hit the pads of a hapless batsman. Or whether a Roger Federer 190km/h serve did clip the line, regardless of the fact that the linesman called it out.

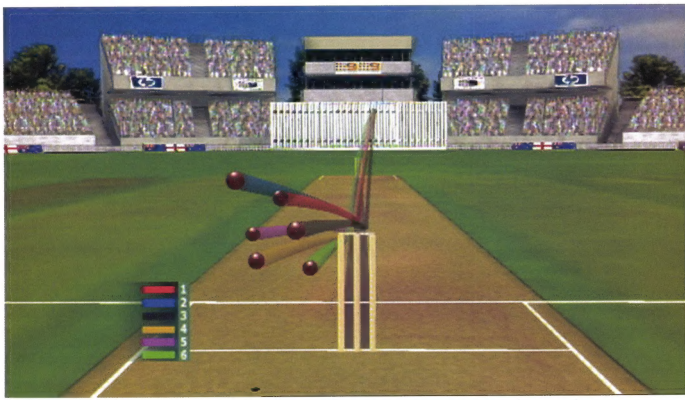
Hawk-Eye is of course capable of a whole lot more, as we will shortly see – but you get the picture.

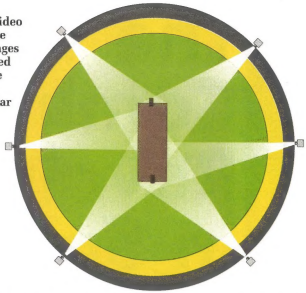
by Ross Tester

It is the brainchild of Dr Paul Hawkins, a 29-year-old PhD who developed the unique system for his employer, Roke Manor Research (itself a division of Siemens), in Romsey, Hampshire, England.

In a nutshell, Hawkins took the extensive research which went into Roke's military tracking system (the single-camera RAPiD system, a model based tracking system which was born out of developments in civil robotics) and applied it to the 3-D, multi-camera world of tracking a ball in flight. Interestingly, Roke developed the military tracking system to track missile trajectories and therefore targets during the Gulf War.

Due to Hawkins' interest in cricket (he's a social player), Hawk-Eye was





In the cricket version, Hawk-Eye uses six fixed video cameras placed around the edge of the arena. The images are electronically compared and analysed to determine the ball's location at any instant. A somewhat similar arrangement is used for tennis.

first developed for the cricket pitch. Since then, it has been developed for tennis, baseball and even snooker/pool. The name, by the way, is Paul Hawkins' father's nickname – and it also very aptly sums up the system itself!

Hawk-Eye was launched in 2001 and in that year won the Royal Television Society award for Technical Innovation.

Why use Hawk-Eye?

There are few more frustrating things to a sportsman or woman (and therefore to millions of fans) than a "bad call" by a judge, umpire or other official. Worse is when that bad call has a major influence on the outcome of the game.

The problem is, of course, that many of the decisions officials have to make are for events which last no longer than the blink of an eye. In many respects, it's a wonder that officials do manage to get it right most of the time. And believe it or not, they do.

Take cricket, for example. A lot of umpiring decisions are relatively easy: that delicious sound (for a fast bowler!) of leather crashing into the stumps and the sight of the bails flying high in the air! Catches are usually fairly simple, too – although umpires these days may call on the "third umpire" with the benefit of slow-motion replays if there is any doubt, either if a ball has carried or if it even hit the bat. Likewise, run-out decisions are often assisted by electronic means if the umpire is in any doubt.

Somewhat surprisingly, about the only ruling that isn't currently electronically assisted is LBW (leg before wicket). We say surprisingly because it is in LBWs that electronic assistance is arguably – with Hawk-Eye – now the most certain.

And it is LBW decisions that are usually the most controversial, because they involve a "what if" judgement, as distinct from an event judgement. The umpire must decide not only if the ball was travelling at such an angle and height that it would have hit the stumps were the pads not hit first; he must also judge that the ball also ptched inside the line of leg stump. And if the batsman had advanced down the wicket, it becomes that much harder.

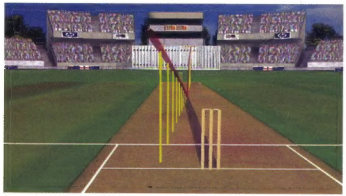
Now put the speed of the ball into the equation: perhaps 150km/h or so and you'll see why errors do occur. In fact, in the first season that Hawk-Eye was used as an aid to commentators, it indicated that 13 out of 21 LBW decisions were wrong – both ways.

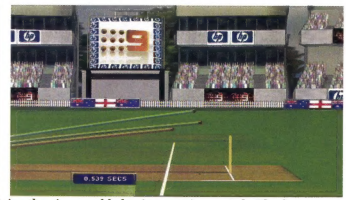
Although initially designed to be used in television coverage, the system could also be used by the umpires to bring a measure of consistency into the decisions being made during a match. The final decision on LBW will always be with the umpire but Hawk-Eye would add significant value by making precise measurements which the human finds very difficult.

Perhaps we are getting ahead of ourselves. Hawk-Eye has not (yet!) been used by umpires to assist in their decisions as to whether or not a batsman is out. However, that day must surely come as TV networks not only bring the umpire's calls into question with endless slow-motion replays – now with Hawk-Eye simulations they can prove, with virtually no error, whether the umpire was correct or not.

It will arguably be the public who force the issue eventually, as there is little call from umpires to have the extra technology at their fingertips. This is one of the features of Hawk-Eye – its data can be almost instantly transmitted to the man in the middle to help with difficult decisions.

Using a small hand-held computer or PDA, the umpire can tell straight away whether a batsman should have been out.





Just some of Hawk-Eye's seemingly endless possibilities for giving the viewer added enjoyment in a match. The first screen shows the ball trajectory from the moment it left the bowler's hand; the second the point of impact with the bat (or body!)

Similarly, tennis umpires could have the technology at their disposal for dubious line calls. How many matches have swung one way or the other following an obvious (to the TV viewer!) mistake. They break the player's concentration at the very least.

Not everyone agrees . . .

There has been some reaction from players – both positive and negative, as you might expect. A batsman who has been on the wrong end of too many LBWs is much more likely to favour the system than one who has "gotten away with murder" out in the middle.

Even former cricket "greats" are divided. A newspaper column written by the former fast bowler Dennis Lillee dismissed Hawk-Eye almost out of hand. But Paul Hawkins claimed that article was "probably the most ill-informed ever written about the system . . ."

Dickie Bird, the former UK umpire, was once a critic but is now one of Hawk-Eye's biggest supporters. He originally claimed that it would kill the game but now advocates its use. "Surely the need is to alleviate error," he said.

Similarly, tennis authorities such as the ITF have not yet given Hawk-Eye their glowing endorsement, citing cost as one reason.

However, John McEnroe, commentating during the Australian Open finals, glowingly praised Hawk-Eye and wished it was available to the umpire after a couple of obvious errors in line calls. He even joked with the other commentators when one remarked that it would have put an end to his now famous (infamous?) "You cannot be serious!" arguments with tennis umpires and referees.

Another claim from sports administrators is that Hawk-Eye could be seen to undermine the authority (and skill levels?) of the officials around the court.

They are not unique: most sports over the years have been reluctant to adopt new technology to assist their officials. Having seen this first-hand in other sports, where electronics is allowed to overrule course judges, all I can say is bring it on . . .

How Hawk-Eye works.

The Hawk-Eye system tracks the ball from the moment it leaves the bowler's hand until it stops (or of course from the tennis racket). It does this using both image analysis and radar technology. If required, it then projects the flight of the ball after it has stopped, by extrapolation.

Hawk-Eye can superimpose the batsman in typical stance to show just where the balls faced have actually ended up. It's valuable for later review of performance and also for coaching.

Using dedicated cameras and specialist image processing software, the position of the ball can be located extremely accurately in three dimensions.

On the cricket ground, six fixed and synchronised "JAI" monochrome cameras, with a 120Hz frame rate, are placed around the perimeter of the playing field at specific points – two are 30° off each end of the wicket while two side cameras look directly across their respective stumps. These synchronised cameras track the ball's entire trajectory – at intervals of 1/120th of a second – from the moment it leaves the bowler's hand until it stops.

The six cameras are gen-locked into two sets of three cameras, each set being captured by a Matrox Meteor-II/Multi-Channel frame grabber and the Matrox Imaging Library (MIL-Lite) software.

The resulting images are processed into a 3D image by the Hawk-Eye system which then calculates – in a split second – where the ball pitched, the extent of its lateral movement in the air and off the wicket, its velocity and bounce and – if applicable – exactly where it contacted the batsman's pad.

Positional accuracy is claimed to be no worse than five millimetres, with some references giving Hawk-Eye an accuracy of 1-2mm (assuming fixed camera positions).

The future path of the ball is also extrapolated by fitting the trajectory of the ball into a parametric model, thereby determining whether or not the ball would have carried on to hit the stumps, bounce over, or go past the wicket. Hawk-Eye then uses a Matrox Orion frame grabber to overlay a graphical representation of this trajectory onto a video image.

This image is then encoded and transmitted to a video bank, ready to be virtually instantly accessed by television production staff and commentators.

Tennis uses a similar process to cricket – Hawk-Eye is most useful for determining when a ball is in or out. But for the TV audiences, it has been extensively used to show the action of, for example, a serve and just how far the balls swing.

A market is also seen for Hawk-Eye in coaching – stroke analysis is easy when you can show exactly what the ball does. The South Africans have been using Hawk-Eye for this purpose and last October, the system was installed at the English Academy at Loughborough College, near Nottingham.

Not only cricket and tennis

In partnership with Sunset + Vine, the television production company, Roke Manor Research has established Hawk-Eye Innovations Ltd, an organization entirely dedicated to the development of similar technologies for wider sporting activities and applications. Dr Hawkins is its CEO.

So far, Hawk-Eye has been adapted to baseball – primarily to determine strikes and balls – and is also available for football (particularly gridiron) and even snooker/billiards/pool! **SC**

Acknowledgement:

Much of the information and text for this article originally came from Roke Manor Research and Matrox. Hawk-Eye screen diagrams courtesy of Channel 9, Sydney.

Increase your driving safety with

QuickBrake

Main Features

- Reduces brake light turn-on time by 200ms
- Works with throttle sensors with 0-5V output
- Responds to rapid reduction in throttle sensor output
- Activates relay to power brake lights
- Adjustable timer for brake light on period
- Power-up delay to prevent false triggering at ignition switch-on

Are you concerned about the risk of a rear end collision when driving in traffic? With QuickBrake, your brake lights come on faster than you could ever apply them, giving you literally metres more safety.

Words by Julian Edgar
Design by John Clarke

Back in the March 2003 issue, we covered the advantages of LED brake lights on cars – in addition to longer life and much lower current drain, LEDs reach full brightness far faster than filament bulbs. And the quicker that you can indicate to drivers behind you that you're braking, the less likely they are to run into the back of your car. In fact, using LEDs in your brake lights can provide the following driver with as much as 200ms earlier warning . . . that's 5.5 metres at 100 km/h.

But with QuickBrake you can do even better than this and provide another 200-250ms earlier warning! By combining LED brake lights with QuickBrake, you can give at least 400ms earlier warning that you're stopping – that's 11 metres at 100km/h. It's a brilliant technique that we've not seen anywhere else – even in new cars.

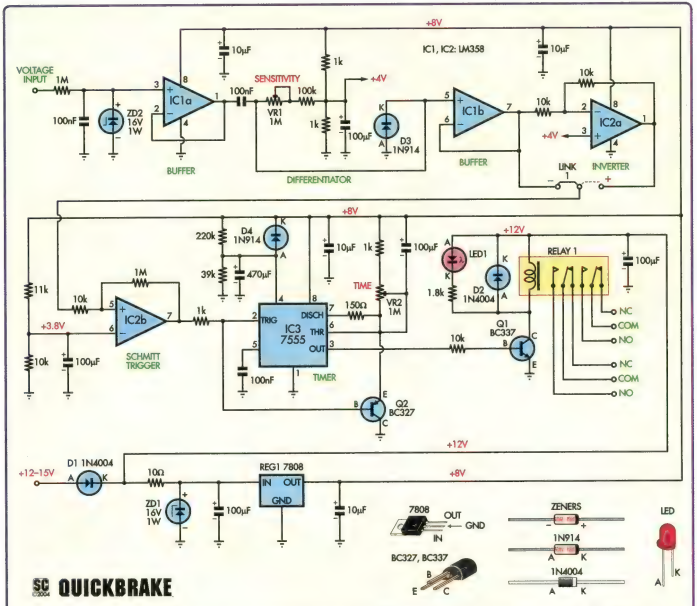


Fig.1: the circuit monitors the car's throttle position sensor and if a rapid negative transition occurs, the 7555 is enabled to briefly activate the relay and the car's brake lights.

Think about what occurs during an emergency stop. You're driving along, mind dwelling on all things interesting – including the other traffic – when you suddenly realise the cars ahead are abruptly stopping. You rapidly lift off the accelerator and then transfer that foot to the brake pedal, quickly jabbing down on it. But "rapidly" and "quickly" are relative terms – in fact it takes about a quarter of a second (250 milliseconds) from the time that you start to lift off the throttle to the time the brake pedal is pushed and the brake lights come on.

But why wait that long before illuminating the brake lights? There's no logical reason – only the engineering tradition of turning on the brake lights with a brake pedal switch.

So why not trigger the brake lights when you rapidly lift your foot off the throttle? "Oh that won't work", you say. Well, why not? With a little circuitry, you can sense the speed of the throttle movement quite easily, just by tapping into the throttle position sensor. Then, if you have the circuit detect a rapid reduction in voltage from the throttle sensor (as happens when you're about to stop in a hurry), you can use a relay to switch on the brake lights. Finally, a timer could be used to hold the relay on to cover the time between the throttle closing and the brake light switch being activated.

This is just what our QuickBrake circuit does. And it's just uncanny watching a car fitted with the project simulate an emergency stop. The brake lights come on "soooooo" fast that you suddenly realise that the pause between deceleration and braking that normally occurs is quite clearly able to be seen, even from outside the car.

QuickBrake can be very handy when you're plagued with a "tailgater" too. If someone is following you much too closely, just lift off the accelerator quickly and the brake lights will

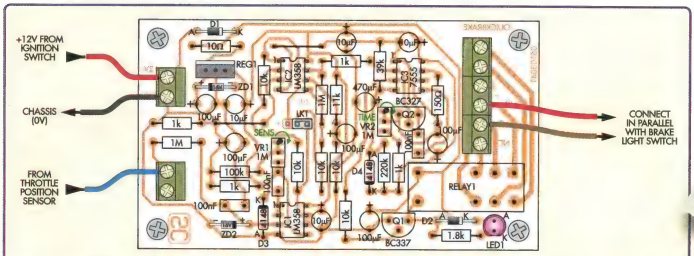


Fig.2: this diagram shows where each of the components is placed on the PC board. Also shown are the connections you need to make when installing QuickBrake in your car. The input signal to QuickBrake is derived from the throttle position sensor output. The Normally Open and Common contacts of the relay are wired in parallel with the brake light switch. Ignition-switched power and an earth connection finish the wiring.

come on for a brief period, without you even having to touch the brake pedal. Nifty, huh?

PC board module

As shown in the photos, QuickBrake is a small PC board module measuring 105 x 60mm. It uses the engine management system's throttle position sensor output to monitor the movements of the throttle.

In operation, it is designed to work with throttle position sensors with an output voltage that varies within the range of 0-5V. *If your car does not have engine management or it uses a throttle position switch (rather than a potentiometer), QuickBrake cannot be used.* You have been warned – you need to check this point out, before you buy the kit!

Circuit description

Fig.1 shows the circuit of the QuickBrake which is based on four op amps (in IC1 & IC2) and a 7555 timer. In effect, the circuit is designed to detect the rapid change of voltage from the throttle position sensor and then close a relay for a brief time. The relay switches on the brake lamps for a pre-determined time. In the meantime, if the driver's foot hits the brake pedal, the brake lights will stay on. If not, the brake lights go out when the relay drops out.

So let's look at the circuit in more detail. The DC voltage from the throttle position sensor is fed to a low pass filter consisting of a 1MΩ resistor and 100nF capacitor and then to op amp IC1a which is connected as a unity gain buffer. From there, it goes to a differentiator consisting of a 100nF capacitor, trimpot VR1 and a 100kΩ resistor. A differentiator can be thought of as a high pass filter – it lets rapidly changing signals through but slowly changing signals are blocked. Putting it another way, if the rate of change of the signal is greater (ie, faster) than the differentiator time constant (RC), the signal will pass through to op amp IC1b, which is another unity gain buffer, and then via link LK1 to IC2b which is connected as a Schmitt trigger stage.

The output of IC2b connects to pin 2, the trigger input of IC3, a 7555 timer. When IC2b briefly pulls pin 2 of IC3 low (as it does for a sudden reduction in throttle sensor signal), IC3's pin 3 immediately goes high, turning on transistor Q1 and RELAY1. This turns on the brake lights.

At the same time, IC2b's brief negative pulse turns on transistor Q2 which pulls the negative side of a 100µF capacitor to 0V and this fully charges this capacitor to 8V. From this point, the 100µF capacitor discharges via trimpot VR2 and the series 1kΩ resistor. This means that the negative side of the 100µF rises until it gets to about +5.3V whereupon pin 3 goes low and transistor Q1 and the relay are switched off. The timer period of

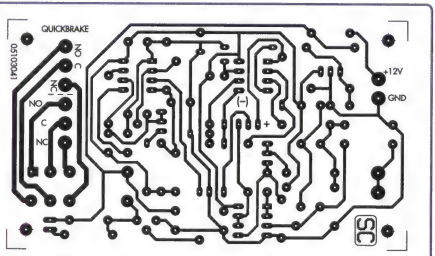
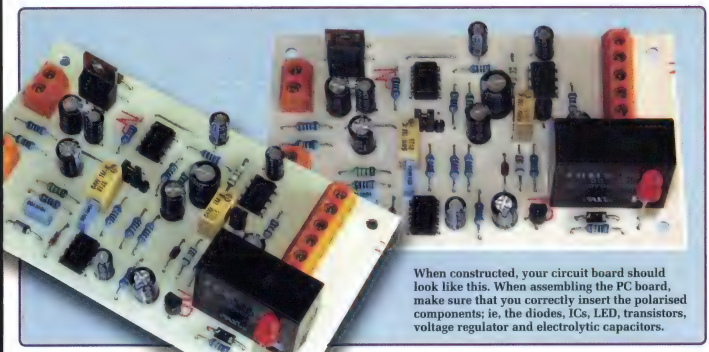


Fig.3: check your PC board against this pattern before installing any parts.



When constructed, your circuit board should look like this. When assembling the PC board, make sure that you correctly insert the polarised components; ie, the diodes, ICs, LED, transistors, voltage regulator and electrolytic capacitors.

IC3 can be set from around 100ms up to 110 seconds, using VR2. In this QuickBrake application, the timer is set to quite a short period, typically less than 500ms.

Diode D2 is connected across the relay coil to quench spike voltages generated each time transistor Q1 turns off. Q1 also drives LED1, via the 1.8kΩ series resistor and this lights whenever the relay is energised. It is handy when you are setting up the QuickBrake circuit on your car.

Power-up delay

Pin 4 of the 7555 (IC3) is used to provide a power-up delay. When the car is first started, we don't want the QuickBrake responding to any unpredictable changes in signal from the throttle sensor; we want all circuit operating conditions to have stabilised before QuickBrake starts operating. Therefore pin 4 of IC3 is connected to a network comprising a 470µF capacitor, diode D4, and 39kΩ and 220kΩ resistors. Initially, the 470µF capacitor is discharged and so pin 4 is low, effectively disabling IC3 so it cannot respond to any unwanted trigger signals to its pin 2.

IC3 is enabled (ie, begins to operate) when the 470µF capacitor charges to around +0.7V via the 220kΩ pull-up resistor. This is after about two seconds. The 39kΩ resistor prevents the 470µF capacitor from charging above 1.2V and this allows it to discharge quickly via diode D4 when power is removed from circuit (ie, when the engine is stopped. This is important so that QuickBrake is properly disabled if the engine is immediately restarted.

Power for the circuit comes from the car battery via diode D4 which gives reverse connection protection. The 10Ω resistor, 100µF capacitor and zener diode ZD1 provide transient protection for REG1, a 7808 8V regulator. All the circuitry is powered from REG1, with the exception of the relay and LED1.

Construction

All the circuitry of QuickBrake is on a small PC board measuring 105 x 60mm and coded 05103041. The component overlay diagram is shown in Fig.2.

Install the resistors first, checking the values with your multimeter as you

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	1MΩ	brown black green brown	brown black black yellow brown
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	39kΩ	orange white orange brown	orange white black red brown
❑	1	11kΩ	brown brown orange brown	brown brown black red brown
❑	5	10kΩ	brown black orange brown	brown black black red brown
❑	1	1.8kΩ	brown grey red brown	brown grey black brown brown
❑	4	1kΩ	brown black red brown	brown black black brown brown
❑	1	150Ω	brown green brown brown	brown green black black brown
❑	1	10Ω	brown black black brown	brown black black gold brown

Parts List

1 PC board, code 05103041, 105 x 60mm
5 PC-mount 2-way screw terminals with 5mm pin spacing
1 12V PC-mount DPDT 5A relay
1 3-way header with 2.54mm spacing
1 jumper shunt with 2.54mm spacing
1 50mm length of 0.8mm tinned copper wire
2 1MΩ multi-turn top-adjust trimpots (VR1,VR2) (Jaycar RT-4658 or similar)

Semiconductors

2 LM358 dual op amps (IC1,IC2)
1 7555 CMOS 555 timer (IC3)
1 7808 3-terminal regulator (REG1)
1 BC337 NPN transistor (Q1)
1 BC327 PNP transistor (Q2)
1 5mm red LED (LED1)
2 16V 1W zener diodes (ZD1,ZD2))
2 1N4004 1A diodes (D1,D2)
2 1N914 diodes (D3,D4)

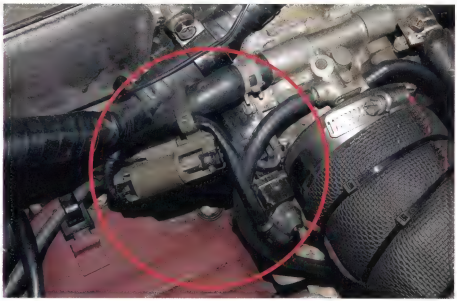
Capacitors

1 470µF 16V electrolytic
5 100µF 16V PC electrolytic
4 10µF 16V PC electrolytic
3 100nF MKT polyester

Resistors (0.25W, 1%)

2 1MΩ	5 10kΩ
1 220kΩ	1 1.8kΩ
1 100kΩ	4 1kΩ
1 39kΩ	1 150Ω
1 11kΩ	1 10Ω

install each one. Use 0.8mm tinned copper wire for the two wire links. Make sure that you insert the polarised components the correct way around. These parts include the diodes, ICs, LED, transistors, voltage regulator and electrolytic capacitors.



QuickBrake monitors the output of the throttle position sensor (circled). When it detects that the driver is lifting off the throttle very quickly, the relay trips, illuminating the brake lights. A built-in timer then covers the period before the brakes are actually applied.

Manual Gearboxes?

QuickBrake may not be suitable for use in manual cars because it may not be able to distinguish between throttle lifts for emergency stops and those used during rapid acceleration through the gears. On the other hand, if you normally drive your manual car in a leisurely manner, it may not have problems.

The relay and the screw terminal strips can be installed last.

Note that there is a trap in the installation of the two trimpots. They can go in either way but they must be installed as shown in the diagram, with the adjustment screw closest to IC2 and IC3 respectively. If you install the trimpots incorrectly, the initial adjustment instruction that we give in the set-up procedure will be wrong.

During assembly, look closely at the photos, Figs.1 & 2 and the parts list to avoid making mistakes.

Unwanted Flashing

If the QuickBrake is set correctly and a competent driver is at the wheel, the brake lights should trigger no more frequently than normal. This is because the project should be calibrated so that it detects only very fast throttle lifts – the sort that are usually immediately followed by an application of the brakes. However, poor drivers who use very jerky on/off throttle movements will cause the brake lights to come on more than usual. Keep in mind that any brake light illumination will still indicate deceleration.

Fitting it to your car

As mentioned earlier, before you buy the kit you need to check if your car has a throttle position sensor (not a throttle switch!). Now is the time to measure the output of the throttle position sensor. This should be done with the engine off (but the ignition on!) by probing the throttle position sensor.

With one multimeter probe earthed (connected to chassis), you should be able to find a wire coming from the connector that has a voltage on it that varies within the 0-5V range as you manually open and close the throttle. Yes, you can manually open and close the throttle by operating the mechanism on the side of the throttle body.

Once you have confirmed that the varying signal voltage is present, make a connection to this wire – ether at the ECU itself or under the bonnet – and run it to the QuickBrake signal input. (Note that you simply tap into the throttle position output wire – you don't need to cut it.)

Next, connect ignition-switched +12V and 0V (chassis) to the QuickBrake. The other connections, to the brake switch, don't need to made at this stage.

Rotate trimpot VR1 (sensitivity) fully anti-clockwise and VR2 (timer period) fully clockwise – this increases the sensitivity of the QuickBrake to

Other Uses For The Circuit

QuickBrake is just one of many applications for the basic module described here. In other applications, the module can be configured (via link LK2) to trigger on quick throttle presses (rather than throttle lifts). In this form, it can be used to sense when the car is being driven hard.

These performance applications will be covered in a SILICON CHIP high performance automotive electronics special.

throttle changes and reduces the timer's 'on' time to a minimum (note: both these pots are multi-turn so they don't have a distinct end 'stop'). Place the link in the Link 1 position to configure the QuickBrake to activate with quick throttle lifts. (Link 2 causes the device to activate with quick throttle pushes.)

Turn on the ignition but don't start the car. Wait five seconds (to allow for the ignition-on reset pause), press the throttle and then quickly lift off, checking that the relay pulls-in and the LED lights. The relay should click out (and the LED go off) fairly quickly, so then adjust VR2 anticlockwise and again push down and then quickly lift the throttle. This time the 'on' time should be longer. Adjust VR1 clockwise until the QuickBrake responds only when the throttle is being lifted with 'real life' quick movements.

Note that if you find the relay clicks off after 10 seconds or so, then it is likely that trimpot VR2 is installed the wrong way around. Don't pull it out –just wind the adjustment fully in the other direction.

Once the QuickBrake module is working correctly, make the brake switch connections. These are straightforward – connect wires to both sides of the brake pedal switch and check that when you join the wires, the brakelights come on. Then run these wires to the adjoining "Normally Open" and "Common" connections on the QuickBrake relay connector.

Set-up

Setting up the QuickBrake is also easy. Normally, you'll find that driving on the road actually involves slightly different speeds of throttle movement than you thought during the static set-up, so the sensitivity control (trimpot VR1) will need to be adjusted accordingly. The length of time that you set the timer (VR2) to operate for will depend on how quickly you typically move your foot from the throttle to the brake pedal. It's best to set the time so that it just covers this period.

The PC board fits straight into a 130 x 68 x 42mm jiffy box, so when the system is working correctly, the board can be inserted into the box and tucked out of sight.

Conclusion

If you're often worried about how closely others follow you at highway speeds, this project is for you. We know we've already said it, but it's uncanny how quickly the brake lights come on when a car equipped with QuickBrake is slowing! SC

Need Affordable Bench Test Equipment?

Look to **Escort Instruments**

The range of Bench Instruments from Escort offer you real choices when you need to choose high quality, cost effective instrumentation for your lab or workshop.

Whether you need:
DMM's (to 5.5 digits)
FUNCTION GENERATORS (to 15MHz),
FREQUENCY COUNTERS (to 2.4GHz),
DUAL/TRIPLE OUTPUT POWER SUPPLIES
there is a product to suit you.

Escort Instruments have been building quality products for over 30 years supplying customers and OEM's. Reliability, ease of use and functionality are what sets the Escort range apart.

Talk to NewTek Sales:
Ph: 02 9888 0100 Fax: 02 9888 0125
email: info@newteksales.com
NewTek Sales Pty Ltd - Sydney - Melbourne
www.newteksales.com

ESCORT **Escort Instruments - Think NewTek Sales**

NewTek Sales

Silicon Chip Binders

REAL VALUE AT $12.95 PLUS P&P

★ SILICON CHIP logo printed in gold-coloured lettering on spine & cover

★ Buy five and get them postage free!

Available only in Australia. Buy five & get them postage free!

Just fill in the handy order form in this issue; or fax (02) 9979 6503; or ring (02) 9979 5644 & quote your credit card number.

Silicon Chip Publications, PO Box 139, Collaroy 2097

Flash! Is the Zip Disk dead?

How do you move significant amounts of data from one place to another? For years, the ubiquitous Zip disk reigned supreme. Could USB Flash Disks be to the Zip as the Ice Age was to dinosaurs?

Put it on the BUS!

By Ross Tester

Moving large amounts of data – photos, music, video, etc, from one computer to another has been a problem since there have been computers and large amounts of data! If the files were more than a floppy's worth (ie, 1.4MB or thereabouts), smarter solutions needed to be found.

Indeed, very close to home, this problem has caused not just a few headaches here at SILICON CHIP. As you would imagine, magazines like SILICON CHIP have been produced on computers now for many years (thank heavens for desktop publishing, photo manipulation and drawing packages!).

But we don't own a huge printing press capable of printing a 100-page, four-colour magazine (office photocopiers don't quite cut it!)

So if the mountain won't come to Mohammed, Mohammed has to go to the mountain. Ergo, each month we have to send a complete magazine's worth of files to the printers.

Very early on, we used whopping (for then!) 44MB "Syquest" disks – many of them for each issue.

Even progressing to 88MB Syquests helped only a little. They were somewhat unreliable and, being magnetic recordings, occasionally suffered catastrophic failure. There were even a couple of times when we were forced to record the magazine on a hard disk, remove the hard disk from the computer, package it very carefully and then airfreight that to the printers. (Don't knock it – it worked. And got us out of some tight spots!)

We also used ZIP disks – both in their original 100MB format and their 250MB reincarnation. The disks themselves were usually very reliable in the short term but we found the drives left a little to be desired mechanically. We had several failures in the one year. Besides, ZIP disks were/are relatively expensive.

SILICON CHIP was a very early adopter of CD-ROMs (back when CD writers operated at x1 or x2 maximum and discs were several dollars each!). To this day, we still record the bulk of the magazine (usually about 500-600MB per issue) on a CD-ROM and despatch it to the printer. At least these days we have 40x and 50x writers.

It is very difficult to buy a computer

Physically small enough to carry around on your keyring, capacity-wise large enough (if you pay enough!) to take your sensitive data with you. This one is a 32MB drive but you can now get them up to 2GB.

They've been faithful servants, but maybe it's time they were retired. . .

without some form of CD writer (or rewriter, or DVD writer, etc) installed – so just about everyone has one. So what's wrong with the average person using CD-ROMs to transport data between computers?

Nothing, much. Except that copying files to a CD or DVD is certainly not as simple as copying files to, say, a hard disk (or even a ZIP).

It is not an instant process and CD writers are definitely not fault (or interruption) tolerant in the recording process.

And if you are in a screaming hurry (eg, the courier is tapping his fingers loudly on the reception desk), Murphy's law says that's when you are going to write a "coaster".

Besides, what if you only need a relatively small amount of data – say a few dozen megs or so. Writing to a 660MB CD seems to be something of a waste to us, even taking the low cost of CDs these days into account.

We're not trying to dismiss CDs out of hand – as we said, we use them regularly. But for the casual transporting of data between machines, there is a better way!

Enter the USB . . .

There probably wouldn't be a computer sold today that doesn't include at least two (and sometimes more) Universal Serial Bus, or USB, ports. USB offers high speed and reliable data communication (especially in its newest incarnation, USB2.0).

The USB standard was developed by a consortium of organisations including Compaq, Hewlett-Packard, Intel, Lucent, Microsoft, NEC and Phillips.

The main difference between the USB port and the serial or parallel ports which have been on computers virtually since day one is in the way data is transmitted. Serial and parallel ports send data bit by bit. The USB organises the data into "packets" and sends those.

Because of this, a USB port requires only four wires – two for power and two for data. (See the separate box which explains more about the USB port).

It took some time for the USB to catch on. Indeed, in the early days there was so little call for USB devices (or more likely so few USB devices available) that for some time case manufacturers kept USB ports on the back panel of the computer – about the most inaccessible place they could be.

But over the past couple of years, we have seen a plethora of USB devices released – so much so that just about every computer sold these days has the USB ports on the front panel and many motherboards support four USB ports. If not, inexpensive add-on cards can give you more USB ports for your computer.

While you can buy just about any peripheral these days to operate via a USB port, the thing that most interests us here is the range of USB storage devices now available.

Most particularly, we are looking at some of the "flash disks". These are available in many formats – we're going to look at a few of these in more detail shortly – but apart from their healthy storage capacities, the most noticeable thing about flash disks are their size (or lack thereof!)

Most are only a couple centimetres wide and perhaps five or so long. If you have to carry data around with you, or move it from PC to PC, this surely must be the simplest and easiest way yet.

What's more, on most modern machines, when you plug one of these USB devices in, the computer not only recognises it immediately but assigns a drive letter to it, making it "just another hard drive" on your computer. Anything you can do with a traditional hard disk drive, you can do with a USB flash disk drive.

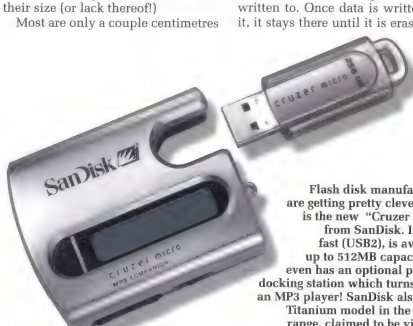
Flash "Disk Drive"?

No, they're not – disks nor drives! The term has stuck because everyone is used to, well, disk drives, where things (disks) spin inside and make whirring noises!

The name can be a bit confusing – a flash disk is entirely solid state; there is no mechanical "disk" to "drive". In fact, a flash disk is a type of EEPROM, (electronically erasable programmable read-only memory). The "ROM" part can be anything from 16MB right up to 1GB and now beyond. (2GB are available but they're expensive).

That's a rather impressive amount of storage for something that can not only be hidden in the palm of your hand (or even between your fingers!), it can often be hidden inside other devices such as watches, pens, etc. We'll look at some of these shortly.

Unlike other forms of memory, the flash disk does not need constant power, just while being read from or written to. Once data is written into it, it stays there until it is erased and



Flash disk manufacturers are getting pretty clever – this is the new "Cruzer Micro" from SanDisk. It's very fast (USB2), is available up to 512MB capacity and even has an optional portable docking station which turns it into an MP3 player! SanDisk also has a Titanium model in the Cruzer range, claimed to be virtually indestructible.

re-written. Again, this lends itself very much to a portable format.

USB flash disks are, by and large, "hot swappable" – another big advantage over many other forms of storage. You don't have to power down the machine, swap the drive, and power back up again. It can be inserted and removed at will, with just a couple of provisos:

(a) Do we have to say it? You must never remove flash disks (or any form of storage) while being read from or written to (most types of flash disks have a LED on them to warn you when "in use", *a la* the hard disk LED on your PC). Not only would data be lost, the chances are very high that other data already on the flash memory would be scrambled.

(b) While you can simply remove the device from the USB port once writing is finished, most operating systems don't particularly like this and give you a stern warning when you do it (you almost expect a hand to come out of the monitor and slap you on the wrist).

The operating systems like to be told that you're about to remove the USB device and give you an icon on the task bar to allow you to do this easily. They then graciously give you permission!

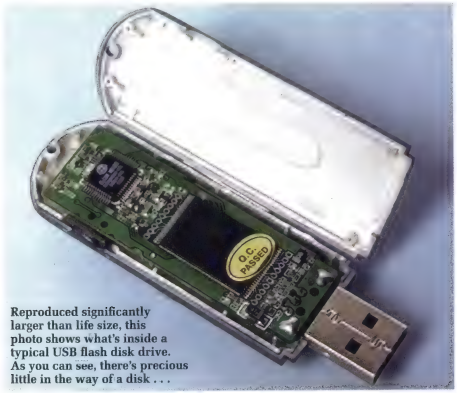
With the exception of Windows 98/SE, you normally don't need any drivers. You simply plug 'em in and your computer will tell you that it has found the disk and is ready to rock and roll. It will simply assign the next available drive letter in your system unless you specify otherwise (which you can easily do).

Why would you do that? I have made my USB flash disk drive "U" (U for USB) in all computers I use it in, because some software I use insists on a certain drive/directory/file setup and gets confused otherwise.

Nobody really knows (yet) how long that data will stay in memory without power. Various sources claim between ten and forty years (yes, years) – but we're going to have to wait for quite a while to verify those claims.

By the way, USB Flash Disks, in all their varieties, are not the only place you'll find flash memory used. It's everywhere these days – from the memory card inside a digital camera (and they are also available in many varieties!) to video games consoles, to the PC-card memory used in notebooks and laptops . . . even your computer's BIOS chip is likely to be flash memory (definitely an EEPROM at any rate).

This is a REAL USB Pen Drive – complete with the pen! The flash disk is in the top half of the pen and is unscrewed from the body to reveal the USB connector (see inset).



Reproduced significantly larger than life size, this photo shows what's inside a typical USB flash disk drive. As you can see, there's precious little in the way of a disk . . .

USB Flash Drives

These are commonly available and are now getting quite cheap. Sometimes they are called keyring memory because they are small enough to go on a keyring. Other suppliers call them pen memory (though that could be confusing, as we will see in a moment).

Our sample 128MB drive came from Oatley Electronics in Sydney (**www.oatleye.com**; 02 9584 3563) who have drives from 16MB to 512MB. Most of them are 78mm long, 22mm wide and 11.8mm deep (the largest drive is 82mm long). There is a write-protect switch to prevent you accidentally destroying data.

Prices from various suppliers vary enormously – we found Oatley's compared well. The 16MB sell for $24.00, while the 512MB sell for $340.00. Obviously, the larger capacity drives are the best value at about 66c per megabyte.

Look, it's a watch. No, it's much more than that: it's also a 128MB flash disk drive. This one is from Dick Smith Electronics and sells for $99.86. The package includes a driver CD and USB extension cable. This drive has the incredible advantage (for me) of going wherever I go – no more lost data or lost disks!

And here is the interface: a standard USB cable (albeit pretty short!) which normally hides in the watchband. By the way, this watch is definitely NOT waterproof . . .

They're supplied with a USB extension cable and a mini CD containing Win98SE drivers and other goodies. A neck lanyard is also supplied so you can actually wear the disk!

The latest models from Oatley have a couple of new really worthwhile features: an advanced email server; Zip compression and decompression to pack more onto your drive; a PC lock (you can use the flash drive to lock your PC – just be careful not to lose the drive!); and data encryption so if you do lose the drive, no-one else will be able to read it.

One of the biggest advantages of these drives, the tiny size, is sometimes a disadvantage to me: I'm forever losing it in the bottom of my briefcase!

Similar flash drives are also heavily flogged on Ebay so if you're an Ebay user and prepared to take some risk, you might save a little bit. And at least one US webstore was selling a 128MB flash drive for $US19.99 (about $AU26) around Christmas time!

Since starting the research for this feature, one problem with flash drives has emerged. We said they are tiny but perhaps, not tiny enough for some computers.

Flash drives have the USB connector moulded into the end of the case, usually with some form of collar around the end. We have come across several notebook computers where the USB port is recessed slightly into the case and the collar prevents the connector making reliable contact (sometimes not at all).

In this case, the simplest answer is to use the USB extension cable that is supplied with many flash drives (or is available from computer stores very cheaply).

Pen drives

Remember we said before that calling flash drives "pen drives" could be confusing? Here's why: we found a flash drive actually built into a pen! The top part of the pen unscrews to reveal a USB plug – the drive's indicator LED is built into the pen case top.

These pen drives operate exactly the same as a "normal" flash drive. And, surprise surprise, just like a normal pen (OK, so maybe just a tad heavier than your Bic Biro!). They come in a gift box with a mini CD driver disk.

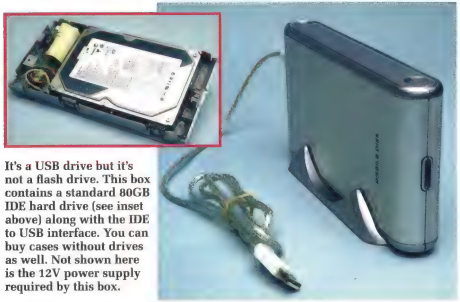
Again available in capacities from 16MB to 512MB, these came from an Ebay shop: Chansnetwork. Once again, prices vary depending on size – they range from $27.00 for 16MB through to $280.00 for the 512MB version. Again, the larger the capacity, the better value – the 16MB costs $1.68 per megabyte; the 512MB costs 54c per megabyte.

You can access chansnetwork via Ebay (search USB pen) or give them a call toll free on 1800 002 810, ext 8633.

USB watch drive

If you thought the pen drive was nifty, have a look at this one from Dick Smith Electronics. It's a USB flash drive built into a fully functional, fashionable man's watch.

It looks just like a digital camera – and it is, until you want it to become an emergency flash disk drive!



It's a USB drive but it's not a flash drive. This box contains a standard 80GB IDE hard drive (see inset above) along with the IDE to USB interface. You can buy cases without drives as well. Not shown here is the 12V power supply required by this box.

There was (at time of writing) only one capacity available, 128MB, and this sold for $99.86. That compares very favourably with either the flash drives or the pen drive above AND you get a great-looking watch thrown in.

For reasons best known to themselves, DSE call it the Dataspy (Cat XH8138). You also get a full-size CD with a user's guide (PDF), drivers for Win98/98SE and OpenOffice.org plus ZoneAlarm software. There's also a quite comprehensive printed user manual.

I mentioned before that I am forever misplacing the flash drive because of its tiny size. Same thing will happen, I'm sure, with the pen drive. (Where did I leave my pen?). It simply won't happen with the watch drive because it's there, on my wrist, when ever I need it.

The connection to the USB port is made via a small (50mm) lead which normally sits in the watch band. Like the flash drive, an extension cord is provided for the USB port so you don't even have to remove the watch to read the disk (just remember to disconnect yourself before you walk away!).

I'm not exaggerating when I say that everyone who has seen the DSE Dataspy is impressed – the usual comment is "I've gotta have one of those!".

You can get yours at any Dick Smith Electronics/DSE PowerHouse store, or mail/net order (1300 366 644 or **www.dse.com.au**).

Thinking outside the box . . .

A few weeks before starting this feature (before I acquired these goodies!) I needed to move, in a hurry, some large (50MB) graphics files between two computers several kilometres apart. Trouble was, I didn't have any means to do it. And as luck would have it, my CD burner was in yet another machine.

I figured I had two choices. Move the CD burner (naaaaah!) or "ftp" the data over the 'net – but I really didn't want to wait the eight hours or so it would have taken on my (painfully slow) dial-up connection. What to do?

It suddenly dawned on me that I was looking straight down the barrel (or should that be lens?) of the answer: my digital camera! It too has a flash disk inside it – in this case, a 64MB SmartMedia card. And it has a USB connection cable. When plugged in and turned on, the camera behaves just as any hard disk drive, just like the flash memory.

I reasoned that being the case, I should be able to read and write to the camera card – and it could! I copied the files I needed to the camera, unplugged it and transported it. I plugged it in the other end: presto, another hard drive.

I am not saying every digital camera will work like this. But I would assume the vast majority would – if they operate via the USB port and have a drive letter assigned, you should have no problem.

Thinking *inside* a box!

OK, so we have extolled the virtues of USB flash drives. But what happens if you want REAL storage capacity – more than the one or two gigs currently available.

Of course, there is an answer. It's not a flash drive – though it behaves pretty much the same (you plug it in to the USB port and away you go).

It's a bog-standard 3.5-in IDE hard disk drive (in this case an 80GB Seagate), mounted inside a case which also contains an IDE-to-USB converter. Because "normal" IDE drives also require 12V, there is an also an external plugpack mains supply.

We found this solution at one of our usual computer suppliers, Cam1 (**www.cam1.com.au**; 02 9999 5600), although these are also very commonly available at computer stores and through Ebay. With the drive, it cost us $350.00

We've also seen these cases sold without drives (significantly cheaper), so you can put your own one in (or change it as required).

Incidentally, you can buy similar cases for 2.5-inch "notebook" drives (these don't need an external supply because they need only 5V and this is available from the USB port).

These "Dazzle" USB card readers from Oatley Electronics accept a variety of flash memory cards and can also be used for data storage – if you happen to have the right card! The readers themselves are very cheap.

These are also much cheaper – you shouldn't pay much more than about $30.00 -$50.00.

Card readers

Before we finish with USB devices, it's worth noting how cheap USB card readers have become lately. Oatley Electronics have them for $6.90 each, with models handling secured digital/multimedia, CompactFlash, or SmartMedia cards. (If you buy all three, you can get them for $15.00).

Jaycar Electronics (**www.jaycar.com.au**; 1800 022 888) have a 6-in-1 internal USB card reader for $54.95.

These cards are all examples of flash memory in use. You can write to or read from these cards just as you would a normal USB flash disk.

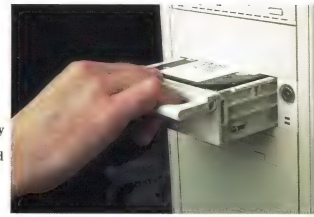
We found the reader particularly handy because we'd recently purchased a second SmartMedia card for the digital camera. So when not needed for the camera, the card became yet another hard disk.

Depending on the computer and operating system, it could be as simple as plugging the reader in. If drivers are needed, they can be downloaded from the Oatley website.

Removable drives (non-USB)

These have been around since Adam played half-back for the under-7s, so it's unlikely you haven't at least seen them advertised, if not used them yourself. We looked at them in detail way back in the October 1997 issue.

First, what they are not: unlike all of the other storage media we've looked at in this feature, they are not a USB drive. What they are is a standard IDE hard drive used on the IDE bus, just like your normal (internal) IDE hard disk drive. A plug-in drawer contains the hard disk drive, while a matching caddie is located inside the computer, with the drawer pushing into place via a flap.



This is a standard IDE drive in a removable drawer (often sold as a "Mobile Rack") and for some time has been a popular method of making data portable. However, we have had a few instances of data loss or damage, possibly due to poor contacts between the drawer and the frame.

The caddie has a multi-pin socket and the drawer a matching plug; when pushed home the two mate and provide all the connections (data and power) required by the drive. They're quite cheap and readily available at most computer stores or Ebay.

The drawback (pardon the pun!) is that you need to buy more than one caddie if you are going to use them on more than one machine. Of course, if you buy two sets you can also use a second hard disk.

One point to note about these drives if you use an older (slower) drive: if you fit the drawer drive as the slave drive on your primary IDE port (ie, the port which also has your master drive), the master drive will be crippled back to the speed of the older drive. It's always best to fit the draw drive as the slave on the secondary IDE port, the one which has your CD-ROM or CDR on it as master.

Finally, these drives are exactly the same as any other IDE drive – you must power down before removing the drawer – unless you buy one specifically intended for "hot swapping". These are not uncommon but are more expensive.

We must be honest here: over the years we have had problems with this drawer system. Perhaps it's oxidation of the contacts; we're not sure.

But there have been intermittents and loss of data, even a dead drive – to the extent where now we do not trust them (nor use them!). Not when USB flash disks are available!

TAKE YOUR PIC

Picaxe.com.au

DISTRIBUTOR: MicroZed.com.au

Developed for students, & professional performance
makes PICAXE the most easy-to-use micro ever:
PICAXE "programmer" is two resistors and a 4.5V battery!

PHONE (02) 6772 2777 9-5
FAX (02) 6772 8987 24 Hours

ALL PICAXE ITEMS ON OUR SHELVES!

STOCKISTS

In AUSTRALIA:
altronics.com.au
School Electronic Supplies (John - 03 8802 0628)
And for chips in Australia: oatleyelectronics.com

In NEW ZEALAND (South Island):
sicom.co.nz
In NEW ZEALAND (North Island):
surplustronics.co.nz

About the UNIVERSAL SERIAL BUS . . .

As you may know, there have been two versions of USB – USB1 (or more correctly 1.0 then 1.1) and USB2. The difference is mainly speed: USB1.1 allowed a data throughput of between 1.5 and 12MB/s, the newer version 1.5, 12 and a whopping 480MB/s.

While 12MB/s is quite respectable, the differences are quite staggering. Looking at manufacturer's data sheets, a typical flash drive could back up 1MB of data in 17min 33sec via USB1.1. Via USB2 this would be thirty times faster at just 37sec. Transferring 50 hi-res (25MB) digital photos or MP3s wouldn't be quite so dramatic: 32 seconds vs 7 seconds, or about five times faster.

USB 1.1 and USB2 are usually (with some exceptions) interchangeable because USB2 encompasses low and medium speeds as well. Most plug-in USB flash drives conform to the USB1.1 standard.

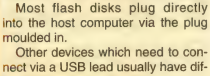
The USB port has four contacts. Pin 1 is typically colour coded red (+5V), pin 4 brown (power ground) and pins 2 and 3 connect to a twisted pair (yellow and blue) to carry the data. The cable is also shielded.

The USB cable is generally limited to five metres and up to 500mA can be supplied from the port for devices which need power, although many USB peripherals have their own power supply. Needless to say, USB flash disks do NOT fit into this category.

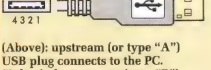
Upstream and downstream

Most flash disks plug directly into the host computer via the plug moulded in.

Other devices which need to connect via a USB lead usually have different plugs on each end.



(Above): upstream (or type "A") USB plug connects to the PC. (Below): downstream (type "B") connects to the USB device.



The USB plugs are designed to work a certain way around. The "upstream" connector (also called a type "A" connector) is designed to plug into to the host computer. Conversely, the "downstream (or type "B") connector plugs into the USB device. Most type "B" plugs are smaller and squarer than the flat, rectangular type "A". Note that there are at least three (and probably more) sizes of type "B" plugs, depending on the manufacturer of the USB device.

There are also USB "extension leads" which have a type "A" connector on one end and a socket the same as the host PC on the other end.

Using hubs

Up to 127 USB devices can connect to the host device, either directly or (if you run out of ports) via a USB hub. Two and four-port USB hubs are very common (and cheap!), while larger numbers of ports are not hard to get.

Hubs can be either self-powered (via a supply) or themselves powered by the USB bus. If you need to add power-hungry USB peripherals (or a lot of them!) you'll need self-powered USB hubs to ensure enough power is available. Also, if you wish to exceed the 5m limit, you can do it by daisy-chaining hubs.

How does it know?

When the host computer powers up, it queries (or "polls") all of the devices connected to the bus and assigns each one its own address. This also occurs when a new device is plugged in.

If the device is a flash drive (or even contains a flash drive, such as a digital camera), the host computer then assigns the "drive" the next available drive letter. From then on, it behaves just like any other disk drive until it is removed.

Each device is queried as to what type of data transfer it wishes to use. There are three types:

Interrupt - A device which sends little data, such as a mouse or keyboard, would use the interrupt mode.

Bulk – Where data is received in one big packet (for example in a printer), the bulk transfer mode is used. A block of data is sent to the printer (in 64-byte chunks) and verified to make sure it is correct.

Isochronous – A streaming device (such as speakers) uses the isochronous mode. Data streams between the device and the host in real-time, and there is no error correction.

The host keeps track of the total bandwidth that all of the isochronous and interrupt devices are requesting. They can consume up to 90% of the 480Mbps of bandwidth that is available. After 90% is used up, the host denies access to any other isochronous or interrupt devices. Control packets and packets for bulk transfers use any bandwidth left over (at least 10%).

The Bus divides the available bandwidth into frames with the host controlling them. Frames contain 1,500 bytes with a new frame every millisecond. During a frame, isochronous and interrupt devices get a slot so they are guaranteed the bandwidth they need. Bulk and control transfers use whatever space is left.

Pin	Name	Description
1	VBUS	+5V DC
2	D-	Data –
3	D+	Data +
4	GND	Ground

USB Port pin assignments.

A close-up view of the USB port as would be fitted to your PC.

System compatability

On the PC, USB works with most recent operating systems from Windows 98 on. It also works on the Mac. Drivers will probably need to be loaded for Windows 98/SE but more recent operating systems (eg, Me, 2000 and XP) have the drivers built in.

However, if you run Windows 95 or Windows NT on your computer, you're out of luck. Neither recognise the USB – Win95 because it is simply too old; WinNT because it was never designed to work with USB. SC

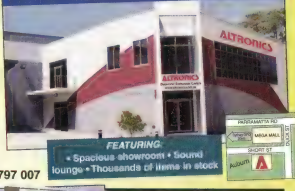
ALTRONICS

Announcing the release of our 20th edition 2004/2005 catalogue.

- Full colour 308 pages
- Over 1500 new products
- Easy to use format
- Improved specifications
- Revised data section

Celebrating over 27 years in the industry and the release of our brand new 2004 catalogue here are some specials to take advantage of this month...

NEW SYDNEY STORE NOW OPEN!



Didnt receive your free copy with Silicon Chip?
Simply register online at: www.altronics.com.au/wnew or call us on **1300 797 007**

Prevent accidental blow-ups!

OVER 50% OFF!

Ever accidently blown up your meter from using the wrong probe terminals on the wrong range? Well **NO MORE!** The lockout DMM features special shutters which prevent you from using the meter incorrectly. Great for beginners! **Features:** Hold function • Momentary backlight • Temp & Capacitance measurement • K- Type temp probe included • Diode check • AC 200mV-700V • DC 200mV-1000V • Current 2mA-10A

$30 Q 1160 Normally $65

Your own weather station!

A stylish blue backlit hygrometer, barometer and thermometer unit. The handy barometer predicts the weather ahead of time! Also features alarm clock (with snooze), date and day display.

$45 A 0170 Normally $59.95

With in-built alarm clock!

100W of Go-Anywhere Soldering!

NEW!

$99 T 2599 Normally $129

The perfect gift idea for enthusiasts or hobbyists.

Kit includes: • Soldering iron • Cleaning sponge • Solder dispenser • Blow torch tip • Hot knife cutter tip • Hot air blower tip • Heat deflector for heatshrinking • Spare gas filter

60W Pro Soldering Station

Top of the line with all the bells and whistles! Featuring tip temperature display and quality Japanese ceramic heating element for rapid heat recovery. **Features:** • Dual mode LED temp display • Zero-volt switching • Light weight ergonomic mini handle • Temp range 200 - 500°C • Temp lock facility **NEW LOW PRICE! SAVE $21!**

$229 T 2438

FREE $40 BONUS PACK* Purchase the T 2438 & receive a free T 2439 solder holder and a 1kg roll of T 1115 solder (as shown) valued @ $40.55.

Handy, ultrabright LED headband torch.

NEW!

HUGE 80hr BATTERY LIFE! Great for working on cars or on fiddly PCB's. Batteries and headband included.

$20 X 0196 Normally $29.95

Super-compact, with 3 ultra-bright 100,000+hour LEDs!

Keyring Model. Great for finding keyholes in the dark! Makes a fantastic gift idea for just about anyone! Batteries included.

$10 X 0192 Normally $14.95

Colour Dome Camera

Simple to install, this discrete dome camera features superb picture quality from its 130° wide angle lens. Perfect choice for home or business security. **M 9236** power supply to suit $12.95

$179 S 9114 Normally $185

Get your point across!

With this great keychain laser pointer. Ideal for lectures, seminars, building sites and guided tours.

Max permitted 1mW power output

$10 A 0205 Normally $14.95

Design Breadboards

With standard 0.1 inch spacing and handy click together boards allowing easy expansion of your designs!

HALF PRICE!

Breadboards	Normally	NOW
P 1000 200 hole	$5.20	$2.60
P 1005 640 hole	$11.05	$5.50
P 1007 740 hole	$12.00	$6.00
P 1009 840 hole	$14.95	$7.45

BARGAIN Power Supplies!

SAVE OVER 60%

These plugpacks have been produced with a fixed tip negative plug. Suitable for all kinds of appliances! 9V, 300mA. HURRY, LIMITED STOCKS!

$8 or 4 for $20 MA9236 Normally $12.95

Brand name sound with a small pricetag.

SAVE $50!

By far the best split system we have evaluated. This 165mm split system enables you to mount the 6.5" mid bass driver in the door, and the dome tweeter on the dash or on top of the door trim for optimal staging. 100W. **Supplied with 2-way crossovers, mounting kit, grille & speaker wire.**

$99 C 9302 Normally $129

Remote control your PC!

NEW!

Can be used to remotely control a PC from the other side of the room, including mouse and cursor movement. Fantastic for lectures when giving multimedia presentations or for controlling a Hi-Fi PC! Controls Powerpoint®, WinDVD®, WinAmp® and Internet Explorer®. • Programmable hotkeys • Suits Win98 or newer • USB connection • Software included.

$75 D 2400

With handy inbuilt laptop light for use in darkened theatres etc.

See your mates LIVE on the net!

NEW!

With your very own WEBCAM!

Simply connects to your USB port to provide an instant web camera with snapshot capability. Wonderful for communicating over the net with family & friends for *FREE!* Features adjustable focus, gooseneck base, inbuilt light for laptops and high quality picture. Software included.

$69 D 0955

FEATURE PACKED DJ MIXER!

FOR THE AMATEUR OR THE PRO

HOT PRODUCT!!!

At last a unit worthy of being called a quality DJ mixer. This rugged, feature packed unit has many features you would expect to find on *"top end"* mixers costing up to **4 times** the price! Sure to enhance your DJ'ing or provide hours of fun. **Features:** • 9 band EQ (+20dB boost / -30dB kill) • Cross fader • Invert switch • Crossfader curve adjustment -(or hampster control) • Full band kill switches • Transform function • **M 9253** plugpack to suit $19.50

$169 A 2546 Normally $199

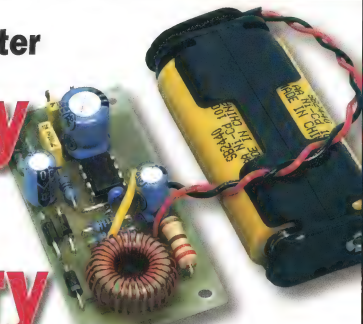
ALTRONICS One stop electronics shops

Perth: 174 Roe St, Perth WA, 6000
Sydney: 15 Short St, Auburn, NSW, 2144
Ph: 1300 797 007 **Fax:** 1300 789 777

Mail Order Hot Line:
1300 797 007

3V to 9V DC-DC Converter

Never buy another 9V battery



Bought a 9V battery lately? They're horribly expensive and they don't last very long if you want more than a few milliamps out of them. The solution: build this little DC-DC converter so you can use AA, C or D size cells instead.

By PETER SMITH

SAY YOU WANT a 9V battery to supply 40mA to a circuit. That's a pretty modest current but if you use a PP3 style 9V battery it won't last long at all. In fact, if you're using a typical "heavy duty" 9V battery, it will last less than 20 minutes before the voltage drops to 7.8V. That may be enough to stop your circuit working. Or maybe you are using an alkaline type. Depending on the brand and price, you might get about two hours life. Not good.

By comparison, two AA alkaline cells driving this DC-DC Converter circuit to give 9V at 40mA will last about 7 hours. And rechargeable AA cells can be even better. Table 1 shows the comparisons.

This circuit can deliver up to 90mA at 9V (with less life from the cells) or can be set to deliver anywhere between 4.5V and 20V. You might never have to buy another 9V battery ever again.

Back in the November 1990 edition of SILICON CHIP, we described a single cell to 9V DC converter suitable for replacing 9V batteries. That design proved very popular and was subsequently updated in August 1992. Unfortunately, the TL496 power supply IC used in both of these projects is now obsolete.

This project is based around the Texas Instruments TL499A, a similar but more versatile variant of the TL496. Most notably, its output voltage is programmable, making it suitable for use in a variety of low-power applications.

Main Features

- Use it to replace 9V batteries
- Runs from AA, C or D cells
- Up to 90mA current at 9V
- Can be set for 4.5V to 20V output
- Supports DC plugpack input
- Optional trickle charge for NiCd & NiMH batteries

Unlike the original TL496 designs, this new design is specified for use with two cells. This enables the converter to produce more realistic output current levels. For low-power applications, two cells are also more cost effective, as more of their energy is extracted before the terminal voltage falls below the converter's minimum input voltage.

We've also included support circuitry for the TL499's on-board series (linear) regulator, meaning that it can be powered from a plugpack when a mains outlet is available. In addition, a trickle-charge function is provided for use with rechargeable batteries.

The PC board is roughly the same size as a 2 x "AA" cell holder, so in some applications it will be possible to build it right in to the equipment that it powers. Alternatively, it could be housed in a small plastic "zippy" box or similar.

TL499A basic operation

A functional block diagram of the TL499A appears in Fig.1. It contains a switching regulator and series regulator. Let's look at the switching regulator section first.

The switching regulator operates as conventional step-up pulse-width modulated (PWM) DC-DC converter. A variable frequency oscillator drives the base of a power transistor, which acts as a switch between one side of a "boost" inductor and ground.

Referring also to the circuit diagram

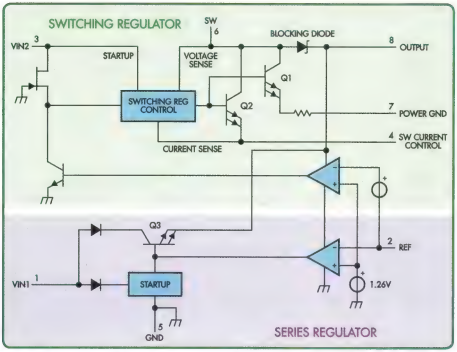


Fig.1: the functional block diagram of the TL499A. It's housed in an 8-pin DIL package and contains both series (linear) and step-up switching regulators.

in Fig.2, you can see that one end of the inductor (L1) is connected to battery positive. The other end is connected to pin 6 of the TL499A – the collector of the switching transistor (Q1).

When the transistor switches on, the current through L1 ramps up with time, storing energy in the inductor's magnetic field. When the transistor turns off, the magnetic field collapses, generating an instantaneous voltage which causes the blocking diode to conduct, thereby transferring the inductor's energy to the output filter capacitor and load via pin 8.

The second transistor (Q2) forms part of a cycle-by-cycle current limiting circuit. This circuit turns off the switching transistor (Q1) when the current through it reaches a predetermined level. A 150Ω resistor from pin 4 to ground sets the peak current level to about 500mA.

The PWM circuit uses a fixed off time/variable on time scheme to maintain a regulated output voltage under varying line (battery voltage) and load conditions. Under light-load conditions, the switching frequency can be as low as a few kHz. With maximum load and minimum input voltage, it increases to over 20kHz.

Now let's turn our attention to the series regulator section. Again, this section is quite conventional, consisting of an NPN series pass element (Q3), a voltage reference and an error amplifier.

DC voltage applied to pin 1 is passed through to the output at pin 8 via transistor Q3. The base of Q3 is driven by an error amplifier, which compares a 1.26V (nominal) reference voltage on its non-inverting input with the voltage at pin 2.

Looking at the circuit diagram (Fig.2), you can see that resistors R1, R2 & R3 close the feedback loop, connecting the output voltage back to the error amplifier's inverting input. The output voltage is determined by the expression:

$$V_{OUT} = V_{REF} (1 + R1 / (R2/R3))$$

Substituting our listed values gives:

$$V_{OUT} = 1.26 (1 + 33k\Omega / (220k\Omega/4.7k\Omega)) = 8.95V$$

In fact, by choosing appropriate values for R1 & R2, the output voltage can be programmed for any value between 4.5V and 20V. A handy list of resistor values for the most common voltage ranges is presented in Table.3.

Regulator priority

A similar voltage feedback scheme is used by the switching regulator control circuits. In this case, however, the error amplifier circuit has been modified so that the output voltage will be about 2-3% lower than from the series

Table 1: Battery Life Comparison

Type	Service Life	Conditions
9V Heavy Duty (Rayovac D1604)	≈ 18 min.	40mA Load, 7.8V Cutoff
9V Alkaline (Rayovac A1604)	≈ 2 hours	40mA Load, 7.8V Cutoff
2 x AA Alkaline (Energiser E91)	≈ 7 hours	230mA Load, (40mA Output), 1V/Cell Cutoff (9V Output)
2 x AA NiMH (2000mAh)	≈ 7.7 hours	230mA Load (40mA Output), 1V/Cell Cutoff (9V Output)

Parts List

1 PC board, code 11103041, 59 x 29mm
1 14.8mm toroid (Neosid 17-732-22) (Altronics L-5110)
1 700mm-length (approx) 0.63mm enamelled copper wire
1 2 x AA (or C or D) cell holder
2 x 1.5V cells to suit cell holder
1 9V battery snap
1 panel-mount 2.1mm or 2.5mm DC socket (optional)
6 1mm PC board pins (stakes)
Hot melt glue or neutral cure silicone sealant

Semiconductors
1 TL499A Power Supply Controller IC (IC1)
2 1N4004 1A diodes (D1,D2)
1 1N4732A 4.7V 1W Zener diode (ZD1)

Capacitors
1 470µF 25V PC electrolytic
1 220µF 25V PC electrolytic
1 100µF 25V PC electrolytic
1 1µF 50V monolithic ceramic
2 100nF 50V MKT polyester

Resistors (0.25W 1%)
1 220kΩ
1 150Ω
1 33kΩ
1 10Ω
1 4.7kΩ
1 270Ω 1W 5%
1 220Ω 1W 5% (for testing)

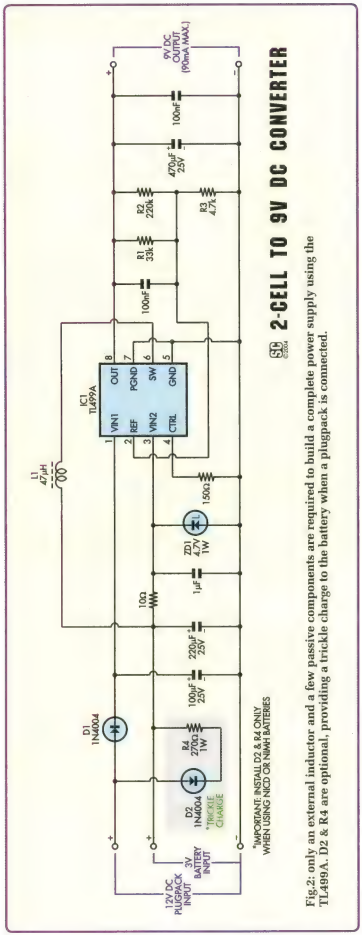


Fig.2: only an external inductor and a few passive components are required to build a complete power supply using the TL499A. D2 & R4 are optional, providing a trickle charge to the battery when a plugpack is connected.

regulator. This gives priority to the series regulator, because its slightly higher output voltage "forces off" the switching regulator.

In practice, this means that when the unit is running from batteries and a plugpack is connected, switch-over between the two sources occurs automatically. Power to the output is uninterrupted, ignoring the small increase in voltage (about 180mV for 9V out). When the series regulator is operating, the switching regulator shuts down and battery drain drops to just 15µA (typical).

Texas Instruments refers to the voltage difference between the switching and series regulators as the "change voltage". For more detailed information on the TL499A, you can download the datasheet from **www.ti.com**

Complete circuit

Very little external circuitry is required to construct a complete power supply using the TL499A. Looking first at the input side of the circuit (Fig.2), the DC plugpack input is polarity-protected with a series diode (D1) and then filtered with a 100µF capacitor before being applied to the series regulator input (pin 1).

At the battery input, a 220µF capacitor compensates for battery lead length, terminal contact resistance and increasing cell impedance during discharge.

Additional filtering is provided using a 10Ω resistor and 1µF capacitor before the battery voltage is applied to the switching regulator input (pin 3). This filter removes much of the high frequency switching noise present on the "hot" side of inductor L1.

Zener diode ZD1 clamps the voltage on pin 3 to less than the maximum (10V) rating of the IC. It also prevents the trickle charge circuit from powering the output side of the circuit (via L1 and IC1), both unwanted side-effects that would otherwise occur when the circuit is powered from a plugpack without batteries installed.

Note: to keep board size to a minimum, polarity protection has not been provided on the battery input. As cell orientation is obvious for most battery holders, you may not be concerned about this omission. However, if your application demands input polarity protection, then the additional circuitry shown in Fig.4 can be inserted prior to the converter's input terminals. A simple series diode will not suffice in this case, as it would seriously impede circuit performance.

Trickle charge circuit

If you're using rechargeable cells, then D2 and R4 can be installed to provide trickle charging whenever a plugpack is connected. A resistor value of 270Ω limits the charge current to about 50mA, dependant on input and battery voltages. This current level is suitable for cells of 1000mAh and higher. For lower cell capacities, you should select a more appropriate value for R4 using the following formula:

$$R4 = (V_{IN} - V_D - V_{BATT}) / (Ah \times 0.05)$$

Where V_{IN} = plugpack voltage, V_D = diode voltage drop, V_{BATT} = fully charged battery voltage, Ah =

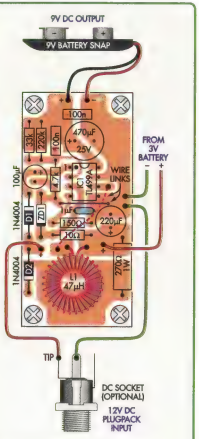


Fig.3: follow this diagram closely when assembling the board. There's no need to wire up the DC socket if you'll only be powering the converter from batteries. Note how the 9V battery snap is wired in reverse (red wire to negative terminal, black to positive) to mate with the existing battery snap in the equipment to be powered.

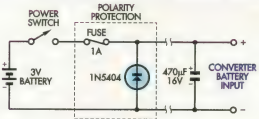


Fig.4: install these components in-line with the battery leads if "fail-safe" polarity protection and/or battery switching is required. The 470µF capacitor may be needed to ensure that the DC-DC converter starts up and regulates properly with the additional series impedance introduced by the switch, fuse and associated wiring.

battery capacity in amp/hours.

For example, if you're using 650mAh cells with a 12V unregulated plugpack that puts out 16V:

R4 = (16 – 0.7 – 3) / (0.65 x 0.05)
= 378Ω (use 390Ω)

Note that while the trickle charge function will top-up your batteries as well as compensate for self-discharge, it is not intended to recharge flat cells. Do not be tempted to increase the trickle charge current beyond the recommended 0.05C rate. Doing so may shorten the life of your cells, or in the extreme case, cause a fire or explosion! If in doubt, refer to the manufacturer's data sheets for the maximum recommended trickle charge rate.

On the output side of the circuit, the 100nF capacitor across the top two resistors reduces ripple and noise in the feedback signal to pin 2. Finally, 470µF and 100nF capacitors provide the maximum permissible filtering ahead of the output terminals.

Voltage and current limits

Using the component values shown, the series regulator (plugpack) input can be as high as 17V. This limit is imposed by the maximum continuous power dissipation of the TL499A (0.65W recommended), as well as power dissipation in the trickle charge circuit.

If you've programmed the output for less than 9V, then use a lower voltage plugpack (less than 12V) to keep IC power dissipation under control. Remember that unregulated plugpacks put out higher voltages than specified when lightly loaded. Ideally, the input voltage needs to be only about 3V higher than the output to achieve regulation and minimise dissipation.

The switching regulator can source up to 100mA of current. Table 4 provides a convenient method of determining the maximum available current for typical input and output voltage combinations when operating from battery power.

Although the TL499A includes in-built over-temperature and over-current protection, you should not exceed the listed current levels to avoid possible damage to the chip. Excessive loading will also cause high ripple voltage and loss of regulation at the output.

Also note that being a step-up (boost) type converter, there is a current path from the battery, through the inductor (L1) and the internal blocking diode to the output, even when the switcher is shut down. The diode is designed for a maximum current of 1A, a level that could easily be exceeded if the output terminals are accidentally shorted together.

About efficiency & battery life

The switching regulator's efficiency depends on the input and output voltages and the load current. As shown

Table 2: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	1	33kΩ	orange orange orange brown	orange orange black red brown
❑	1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	150Ω	brown green brown brown	brown green black black brown
❑	1	10Ω	brown black black brown	brown black black gold brown
❑	1	270Ω (5%)	red violet brown gold	not applicable
❑	1	220Ω (5%)	red red brown gold	not applicable

Table 3: R1 & R2 Values For Common Output Voltages		
VOUT	R1	R2
4.5V	22kΩ	27kΩ
5V	15kΩ	180kΩ
6V	33kΩ	39kΩ
7.5V	27kΩ	180kΩ
9V	33kΩ	220kΩ
12V	47kΩ	270kΩ
15V	56kΩ	560kΩ

Table.3: to program the converter for a different output voltage, just change the values of R1 & R2. Typical voltage ranges together with the necessary resistor values are listed here.

in Table 4, the maximum output current with 3V at the input is 90mA. In this configuration, the circuit is about 55% efficient. Therefore, we can say that with a step-up ratio of 3:1, the input power will be about 1.25W at full load.

This represents a considerable current demand on the batteries. In the case of alkaline batteries, the voltage decays rapidly to less than 1V/ cell under heavy-load conditions, which means that available output power decreases as well.

The most important points to consider are:

(1). Alkaline cells are best suited for intermittent and/or light-load use. The high self-discharge rate of rechargeables (especially NiMH types) makes them unsuitable in this application unless trickle-charged.

(2). Rechargeable cells are best suited for high current, continuous-use applications. Although the initial terminal voltage is less than for alkaline cells, they have an almost flat voltage discharge curve. The lower (1.2V/cell) terminal voltage means that about 70mA max. output current is possible at 9V, but it will be sustainable over most of the battery life.

(3). Carbon cells are not recommended due to the high peak switching current drawn by the converter.

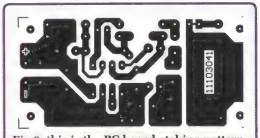


Fig.6: this is the PC board etching pattern.

Assembly

Using the overlay diagram in Fig.3 as your guide, begin by installing the wire link (just below IC1) using tinned copper wire. Follow this up with all the resistors and diodes (D1, D2 & ZD1), taking care to align the banded ends of the diodes as shown.

Note that the 270Ω 1W resistor should be mounted about 1mm proud of the board to aid heat dissipation.

Important: D2 and R4 should only be installed if you'll be using rechargeable batteries and the plugpack input. Do not install these components if using alkaline batteries.

The TL499A (IC1) can go in next. It is important that this chip is soldered directly to the PC board – don't use an IC socket! This maximises heat transfer and eliminates contact resistance. The notched (pin 1) end must be oriented as shown on the overlay diagram.

Install all of the capacitors next, noting that the electrolytics go in with their positive leads aligned as indicated by the "+" symbol.

Winding the inductor

The inductor is hand wound on a 14.8mm powered iron toroid, Neosid Part No. 17-732-22. You'll need about 700mm of 0.63mm enamelled copper wire for the job.

In total, 30 turns are required to achieve the 47μH inductance value. The wire must be wound on tightly, with each turn positioned as close as possible to the last. Do not overlap turns. One complete layer should make exactly 30 turns. Be careful not to kink the wire as you thread it through the centre of the toroid, otherwise you won't be able to fit all 30 turns in the available space.

Bend and trim the start and finish ends as necessary to get a neat fit in the PC board holes. Scrape the enamel insulation off the wire ends with a sharp blade and tin with solder prior to soldering to the PC board.

With the inductor in place, all that remains is to install an insulated wire link between pin 6 of IC1 and the spare

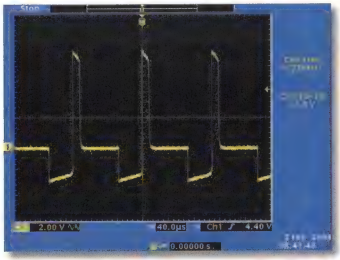


Fig.5: this waveform was captured on pin 6 of the TL499A switching regulator IC with a 40mA load (ie, the 220Ω test load). The switching frequency is a little over 9kHz in this case.

Table 4								
OUTPUT VOLTAGE (V)	BATTERY INPUT VOLTAGE (V)							
	1.1	1.2	1.3	1.5	1.7	2	2.5	3
20						20	25	30
15				15	20	30	45	55
12	10	15	20	25	30	40	55	70
10	15	20	25	30	35	45	65	80
9	20	25	30	35	40	50	70	90
6	30	35	40	45	55	75	95	100
5	35	40	45	55	70	85	100	100
4.5	35	45	50	60	75	95	100	100

MAXIMUM OUTPUT CURRENT (mA)

Table.4: the maximum switching regulator output current depends on the input and output voltages. This table enables you to predict the maximum current for the chosen output voltage as battery voltage declines.

All 1 Watt, 3 Watt & 5 Watt LUMILEDS in stock NOW !!

Luxeon Star
Supplied as displayed in 1 Watt, 3 Watt and 5 Watt (including the side emitting LEDs)

1 Watt Hex Star - White & Cyan @ $15.95
- Blue, Royal Blue, Green, Red, Red-Orange & Amber @ $19.25
1 Watt Side Emitting - All colours in stock @ $19.25

3 Watt Hex Star - White, Green, Cyan, Blue & Royal Blue @ $24.48

5 Watt Hex Star & - White, Green, Cyan, Blue & Royal Blue @ $54.45
5 Watt Side Emitting

NEW

White
Green
Cyan
Blue
Royal Blue
Red
Red-Orange
Amber

Luxeon Star/O
Supplied in 1 Watt with built-in reflector 20°.

1 Watt Star/O with 20° built-in reflector
- Warm White, Cyan, Blue & Royal Blue @ $25.85
- White, Green, Red & Amber @ $21.89

Collimating Lenses

These high prescision moulded optical lenses are supplied for direct mounting onto all standard Luxeon Star 1 Watt, 3 Watt and 5 Watt LEDs. Available in Wide, Medium, Narrow & Elliptical Beams @ $7.95

NEW

NEW

NEW NEW NEW RED/GREEN/BLUE Flashing LEDs

RGB (Red Green Blue) is a 2-Pin 5mm Clear (3 Colour) Super Bright Flashing LED with a built-in microprocessor driven at 4.5VDC drawing up to 90mA. Available with various flashing paterns, Fade-in & Fade-out, Flashing or a combination sequence.

Type 1 - FC350C8110G
Fades from Red to Green to Blue to Red+Green to Blue+Green to Blue+Red to Red+Green+Blue.
Type 2 - FC350C8310G
Similar to above but a 34 step Flash & Fade sequence.

5mm @ $3.95 10mm @ $4.95

Pink Super Bright LED Clear 5mm LED Max: 6000mcd Pink @ $3.25
Purple Super Bright LED Clear 5mm LED Max: 1100mcd Purple @ $3.25

To view a live demo of these products, please visit our web site at www.prime-electronics.com.au or email us at: sales@prime-electronics.com.au

Visit our trade showrooms for a demo. Public welcome.

PRIME ELECTRONICS

BRISBANE SHOWROOM
22 Campbell Street
Bowen Hills QLD 4006
Telephone: (07) 3252 3762
Facsimile: (07) 3252 5778

SOUTHPORT SHOWROOM
11 Brickworks Cntr,
Warehouse Rd
Southport QLD 4215
Telephone: (07) 5531 2599
Facsimile: (07) 5571 0543

SYDNEY
185 Parramatta Road
Homebush NSW 2140
Telephone: (02) 9704 9000
Facsimile: (02) 9746 1197

hole on one side of the inductor. Make this link from medium-duty hook-up wire and keep it as short as possible. That done, the inductor can be permanently fixed to the PC board using hot-melt glue or neutral cure silicone sealant.

Hookup and testing

All connections to the board are made with medium-duty hook-up wire. If desired, PC board pins (stakes) can be installed at each connection point rather than soldering the wires directly to the board.

Note that the wiring length from the battery holder to the input terminals must not exceed 100mm. Where possible, replace existing light-duty battery holder wiring with medium-duty cable and twist the leads tightly together to reduce radiated noise.

The converter draws a small quiescent current (a few milliamps) under no-load conditions. Therefore, for light-load or intermittent use, you'll need to install a switch in series with the battery. Use a switch with a 2A rating or higher. To counter the effects of switch contact resistance (and fuse resistance, if used), you may need to install a capacitor between the switch output and battery negative leads (see Fig.4).

In cases where the converter is to be used in place of a 9V battery, a battery clip can be used to make the connection to the existing battery clip in the equipment. **As shown on the overlay diagram (Fig.3), you'll need to wire the clip leads in reverse, so that it mates up with the correct polarity!**

Before using the converter for the first time, connect a 220Ω 1W resistor across the output terminals and apply battery power. Use your multimeter to measure the voltage across this resistor. If the switching regulator is doing its job, you meter should read close to the desired voltage.

If you'll be using a plugpack as well, then connect it up while monitoring the output voltage. As stated earlier, you should see a small increase in voltage (about 180mV), indicating that the series regulator has taken over and shut down the switching regulator. **SC**

DICK SMITH ELECTRONICS

Benchmark March 2004

$188 LOW PRICE

DSE AVAILABLE AT SELECTED STORES ONLY.

Digital Display Soldering Station

Uses a lightweight 55W soldering pencil fitted with a highly flexible burn-resistant silicon-rubber sheathed cord. Supplied with plated and pre-tinned 1.6mm tip. Uses ceramic heater element with intergral temperature sensor for faster heat-up and temperature control responses. Heater element is isolated from the mains by a highly efficent 24V transformer. T 2250

0-30V 2.5A Digital Display Lab Power Supply

This solidly built laboratory grade linear power supply provides 0-30V adjustable ouptut, with current up to 2.5Amp continuous at all selectable output voltages. An adjustable current limit control (0-2.5A) is also provided. This unit includes seperate voltage and current metering, overload protection and both high current and low curent front panel terminals. Q 1770

$148 LOW PRICE

0-30V DC 5A Lab Power Supply

This solidly built laboratory grade linear power supply provides 0-30V adjustable ouptut, with current up to 5A continuous at all selectable output voltages. An adjustable current limit control (0-5A) is also provided. This unit includes separate voltage and current metering, overload protection,a thermostatically controlled cooling fan and both high current and low curent front panel terminals. Q 1760

$198 LOW PRICE

Resistance Substitution Wheel

Select values from 5 ohms to 1M ohm in 36 steps. Leads and insulated crocodile clips included. Q 1410

$19.98 LOW PRICE

Bench Style Function Generator

Multi-purpose, highly reliable and low-cost 3MHz sweep function generator. Easy to use, with 6 output waveforms and pulse/sweep generator. Q 1826

AVAILABLE AT SELECTED STORES ONLY.

$198 LOW PRICE

20MHz Dual Trace Basic CRO

Dual trace/trigger CRO, fully adjustable sweep time (20 steps) and sensitivity, selectable trigger modes, AC, TV-H and TV-V trigger coupling. Complete with two CRO probes. Q 1802

AVAILABLE AT SELECTED STORES ONLY.

$498 LOW PRICE

UNI-T Digital Multimeter

Covers ranges of AC/DC voltage, DC current and resistance. Tests batteries (1.5V & 9V) and diodes. Includes test leads. Q 1469

$14.98 LOW PRICE

DSE

DC/AC True RMS Clamp Meter

4000 count LCD screen plus bar graph display. AC/DC current range to 1000A. Q 1476

$198 LOW PRICE

3.5 Digit LCR Multimeter

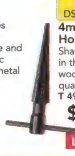
Accurately measures inductance, capacitance, resistance, voltage, logic and frequency. Q 1559

$99.84 LOW PRICE

Anti-Static Tip Solder Sucker

Medium-sized, removes solder from electronic circuits etc. Easy to use and clean with an anti-static Teflon tip and strong metal barrel. T 2567

$9.98 LOW PRICE



DSE

4mm - 20mm Hole Reamer

Shapes and enlarges holes in thin metals, plastics and wood. Made from high-quality treated steel. T 4920

$14.98 LOW PRICE

DSE

Hand-Held Nibbling Tool

Cuts almost any shape or size hole in sheet steel to 0.6mm thick, or light alloy to 1.5mm thick. Also great for many plastics. T 4945

$14.98 LOW PRICE

Logic Probe with Audio Tone

Circuit-powered (4V-18V DC). Switch-selectable for TTL or CMOS circuits with adjustable threshold. Maximum input signal frequency of 20MHz. Q 1274

$29.98 LOW PRICE

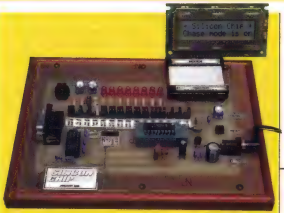
DICK SMITH ELECTRONICS

It starts with LOW prices

www.dse.com.au

We do kits better!

DICK SMITH ELECTRONICS



SILICON CHIP Jan '01

PIC Programmer Kit

Combined PIC programmer and test bed, supports PIC16C84, PIC16F84, and PIC16F84A microcontrollers. Simple programming via Windows-based software, header pins allow easy access to all port lines. Features LCD module support. Supplied with PCB, all components, and instructions. K 3603

$79.87

SAVE $20

Instrument Display Kit

Converts the analogue instruments in your car to a digital display. Ideal for fuel gauges, oil pressure gauges and temperature gauges. Features an alarm output. K 3237

SILICON CHIP Aug '03

$69.88

NEW

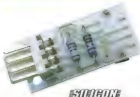
50MHz Frequency Meter Kit

Features a 16 character LCD readout, automatic Hz, kHz or Mhz indicator units, auto ranging and two different resolution modes. K 7001

SILICON CHIP Oct '03

$79.88

NEW

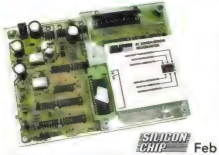


Infrared Port Kit

Build this super simple transceiver and add IR capability to your PC. Supplied with PCB and all components. K 3608

SILICON CHIP Dec '01

$24.96



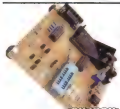
EPROM Programmer Kit

Interfaces to a PC via a standard printer port. Can read and program just about all currently used EPROMs and OTP PROMs directly in its 32-pin ZIF socket. K 3605

SILICON CHIP Feb '03

$99

SAVE $30



PIC Programmer Kit

Program popular PICs as well as serial EEPROMs. Can be battery powered for portable use. Features power supply current limiting which makes it virtually impossible to destroy a PIC. K 3610

SILICON CHIP Sep '03

$59.87

NEW

FM Transmitter Kit

Easy to build mini FM stereo transmitter. Crystal-locked to the selected frequency so there is no drift. Supplied with PCB, case and all necessary components. K 5009

SILICON CHIP Dec '02

$59.84

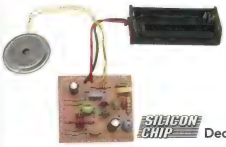
ESR and Low OHM Meter Kit

Measures the equivalent series resistance (ESR) in a capacitor which is often difficult to check with capacitance meters. Complete with all components, hardware, PCB, case and pre-punched silk screened front panel. K 7204

EA Jan '96

$69.96

SAVE $10



VHF FM/AM Radio Kit

Easy to build VHF receiver with slope detection for FM stations. Also receives local VHF AM airport radio services. Supplied with PCB and all necessary components. K 5015

SILICON CHIP Dec '02

$29.87

SILICON CHIP Mar '02

Mighty Midget Amp Kit

This compact audio amplifier module can deliver up to 70W into a 4-ohm load when powered from a 12V car battery. Supplied with PCB and all necessary components. K 5401

$29.88

SAVE $10

and just gets better.

DICK SMITH ELECTRONICS

Swann

Colour OutdoorCam

Automatically switches from colour to infrared black and white images at night (up to 10m), weatherproof and vandal proof casing, connects to TV/VCR/DVR/quad processor or other AV devices. **L 5916**

$178

NEW

POWERWARE

POD 6-Way Surgeboard

6 surge protected outlets and 1 surge protected phone module, auto reset, wall mountable, overload circuit breaker, extra wide spacing on 2 outlets. Free phone support on 1300 303 059. Ideal for applications such as PCs Servers, Mainframes, Comms, Security, Home Entertainment and Industrial Equipment. **M 7655**

$99.82

RadioShack.

Analogue Sound Level Meter

Monitor music or noise level, slow and fast response, A&C weighting, 7 ranges, requires a 9V battery, omni-directional selected sensitivity range: 50-126dB. **Q 0043**

$49.94

Non-breakable solar cells. Lightweight, flexible and durable solar panels. Includes 12V cigarette lighter adaptor, 12V socket, battery clamps and o-ring connectors.

ICP

5W Flexible Solar Panel

O 3305

$239*

NEW LOW PRICE

*AVAILABLE ONLY AT POWERHOUSE STORES AND VIA MAIL ORDER.

ICP

10W Flexible Solar Panel

O 3306

$399*

NEW LOW PRICE

*AVAILABLE ONLY AT POWERHOUSE STORES AND VIA MAIL ORDER.

ICP

15W Solar Panel Plus **$278**

Charges and maintains 12 Volt batteries to help run appliances, may be combined with several units to increase power, maintenance free, weather/shock/rust/UV-resistant frame. **O 3303**

digitor

12V-240V 800W Inverter

Powers most 240V item (eg. TVs, laptops etc.) from a 12V DC power outlet. Output Power 25mins:800W, Output Power Continuous:650W, Output Surge Power:1000W, Output Wave Form: Modified Sine Wave, DC Input Voltage: 10-15V, Low Battery Alarm:10.7V, Low Battery Shut-Down:10V, Efficiency:85-90%, Cooling Fan Overload Protection. **M 5102**

$298

EVERYDAY LOW PRICE

Dual Bubble Light Kit

150mm length tubes, easy installation, capable of 'On/Off/Flash' functions, includes twin tubes, power/function switch, Molex type power connector wiring harness for PCs and an electronic driver.

Blue - Z 8050 Green - Z 8051
Red - Z 8053 Yellow - Z 8054

$19.98#

SAVE 20%

#AVAILABLE POWERHOUSE AND SELECTED DSE STORES ONLY.

Single CCFL tube kit

150mm length tube, tough acrylic casing, easy installation, includes a single tube, power switch, Molex type power connector wiring harness for PCs and an external inverter.

Blue - Z 8030 White - Z 8034
U/V - Z 8033 Red - Z 8032
Green - Z 8031

$19.97#

EVERYDAY LOW PRICE

#AVAILABLE POWERHOUSE AND SELECTED DSE STORES ONLY.

better... much better.

DICK SMITH ELECTRONICS

PCB Copper Expoxies

Heavy-duty epoxy glass PC board with permanently bonded copper on one side

150x75mm Single-Sided PCB Copper Epoxy. H 5540

$3.48

LOW PRICE

300x300mm Single-Sided PCB Copper Epoxy. H 5550

$9.98

SAVE $5.00

Sealed Diecast Aluminium Box

Ideal for outdoor projects requiring both weatherproof and RF shielded enclosures, industrial/commercial applications. Made from corrosion resistant diecast aluminium. Includes copper-plated ground screw and washer. Features a recessed neoprene gasket to meet IP65 of IEC529 and NEMA4 (dust and hose-proof requirements.).

65mm (W), 115mm (L), 55mm (H) H 2233

$7.98

SAVE $8.00

90mm (W), 115mm (L), 55mm (H) H 2234

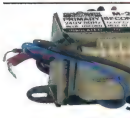
$9.98

SAVE $9.00

121mm (W), 171mm (L), 55mm (H) H 2236

$16.98

SAVE $13.00



$4.98

SAVE $1.00

6.3-0-6.3V 150mA Transformer

Secondary Output: 6.3 - 0 - 6.3V. Secondary Current: 150mA. M 2851

$4.98

SAVE $2.00

12V-0-12V 150mA Transformer

Secondary Output: 12 - 0 - 12V. Secondary Current: 150mA. M 2854

$7.98

SAVE $4.00

15-7.5-0-7.5-15V 15VA Transformer

Secondary Output: 15 - 7.5 - 0 - 7.5 - 15V. Secondary Current: 500mA. M 2860

$7.98

SAVE $8.00

6.3-15V 2A Multitap Transformer

Secondary output: 0-6.3-7.5-8.5-9.5-12.6 15 volts. Secondary current: 2A. M 2156

$9.98

SAVE $16.00

12-30V 2A Multitap Transformer

Secondary output: 0-12-15-17.5-20-24-27.5 and 0-30 volts. Secondary current: 2A. M 1991

$14.98

SAVE $12.00

0-24V 3A Transformer

Secondary Output: 0 - 24V. Secondary Current: 3A. M 2158

Popular 60/40 Tin/Lead Solder

Suitable for use in high quality work requiring free running, low melting point solder.

0.80mm 250g Solder Roll N 2617

1.00mm 250g Solder Roll N 2619

$6.98 ea

SAVE $3.00

600g Ammonium Persulphate Etching Compound

Ideal to Etch circuit boards whilst watching the process. N 5654

$7.98

SAVE $2.00

500mL Ferric Chloride Solution

Long-lasting, reusable at a reduced strength. N 5652

$9.98

SAVE $3.00

Etch Resist Pen Action Marker

Ideal for touch-ups or direct etch boards. N 5181

$9.97

Direct Sales Division

Phone: 1300 366 644 (Local call charge).

Fax: (02) 9642 9155.

Mail: DICK SMITH ELECTRONICS
Direct Sales Reply Paid 500, PO Box 500,
Regents Park DC NSW 2143 (No stamp required)

On sale from 25/2/2004

Limited stock. All stocks marked clearance, limited or with an '' may not be available in all stores or via Direct Sales. Rainchecks do not apply. Offers expire 23.3.2004

and just gets better.

DICK SMITH ELECTRONICS

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

Signal meter for weather satellite receiver

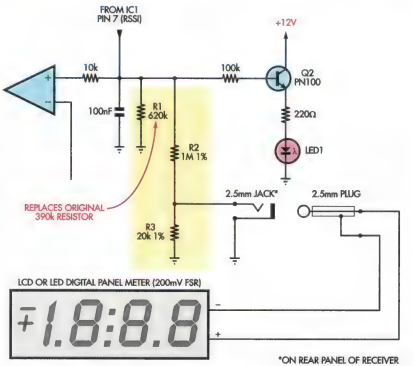
The VHF Weather Satellite Receiver described in our December 2003 issue was provided with just a simple LED indicator to show received signal strength, to keep the size and cost low. However, you can connect an external digital panel meter, if you want a more accurate signal strength indicator.

Only minor changes are required to the receiver circuit, assuming that you will be using a digital panel meter with an input sensitivity of 200mV FSR (full-scale reading) and with an input resistance of 10MΩ or more.

The existing 390kΩ resistor connected between pin 7 of IC1 and earth is changed to 620kΩ (R1). Two resistors (R2 and R3) are added in series, so that they form a 51:1 voltage divider across R1. The output from the divider is taken to a 2.5mm jack socket, which is mounted in a convenient position on the receiver's rear panel.

When the receiver is operating, the voltage across R1 varies between about +0.26V and +5V, according to the received signal strength. As a result the output voltage provided at the meter jack also varies, from about +5mV up to about 100mV. This means that the panel meter will give a signal strength reading that will vary between '5' (no signal) up to '100' (maximum signal).

SILICON CHIP.



Car battery failure detector

A car battery deteriorates in use and its life seldom exceeds four years. When new, its voltage may drop to only 2V while cranking the engine. As the battery ages, its internal impedance increases and so the voltage drop while cranking also increases, until ultimately the drop is high enough to prevent the engine from starting.

This gradual increase in voltage drop while cranking can be used as an early warning of looming battery failure and so this circuit triggers an alarm when the battery voltage drops to 8V during cranking.

The circuit is based on a battery voltage indicator published in the September 1995 issue of "Electronics Australia" and available from

Silicon Chip Binders

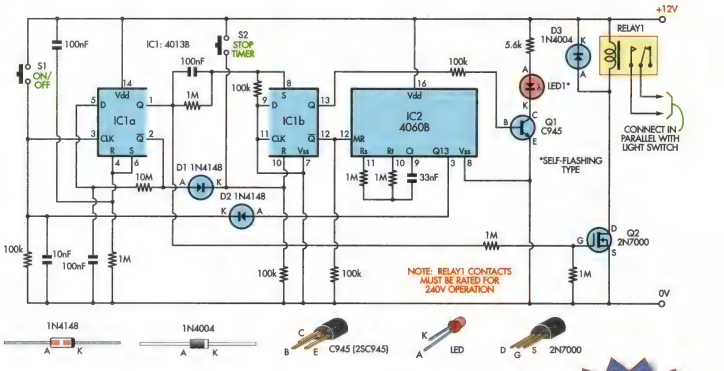
REAL VALUE AT $12.95 PLUS P&P

★ Heavy board covers with mottled dark green vinyl covering
★ Each binder holds up to 12 issues
★ SILICON CHIP logo printed on spine & cover.

Just fill in the handy order form in this issue; or fax (02) 9979 6503; or ring (02) 9979 5644 & quote your credit card number.

Available only in Australia. Buy five & get them postage free!

Silicon Chip Publications, PO Box 139, Collaroy 2097



Switch timer for bathroom light

This 9-minute timer switch can be used to control the light in a toilet or bathroom.

The timer is started by pushing S1 and stopped by pushing S1 again. If you forget to turn it off, the controlled light will go off after nine minutes. If you need the light on continuously non-stop, you need to press S1 (turn on) and then S2 (cancellation of timer) within 9 minutes and in this case the light will be on until you switch it off with S1.

IC1 is a is 4013 dual flipflop. Flipflop IC1a is toggled on and off by switch S1 and it controls the relay which is switched by FET Q2.

IC1a controls IC1b which is connected as an RS flipflop to enable or disable IC2, a 4060 oscillator/divider. This has its timing interval set by the components at its pins 9, 10 & 11.

The relay should have 250VAC mains-rated contacts and these are connected in parallel with an existing wall switch.

Rasim Kucalovic
Liverpool, NSW.

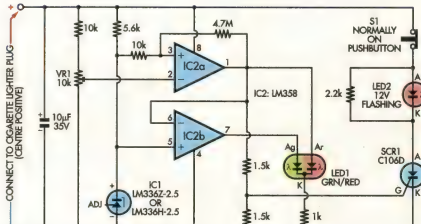
Rasim Kucalovic is this month's winner of the Peak Atlas LCR Meter

Jaycar as a kit (Cat. KA-1778).

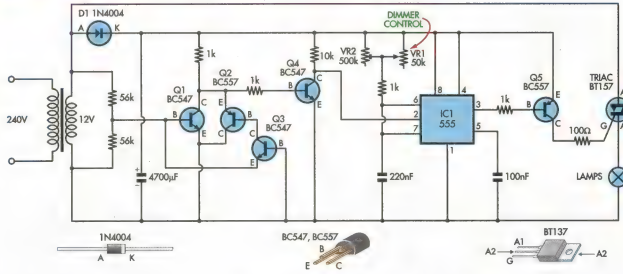
IC1 is a precision 2.5V device used as the reference for two comparators based on IC2, an LM358 dual op amp. IC2a monitors the voltage from trimpot VR1 and normally its output at pin 1 will be low while the output of IC2b will be high and LED1 will be green.

When pin 2 of IC2a falls below pin 3, its output at pin 1 will go high to drive the red section of LED1 to indicate a fault. At the same time, IC2b inverts the signal from pin 1 and its output at pin 7 goes low and turns off the green section of LED1 to indicate a fault.

Since the battery voltage drop occurs momentarily while cranking, a more permanent indication of the fault is provided by flashing LED2. When IC2a's output goes high momentarily, the SCR is latched and LED2 flashes and can only be deactivated by pressing pushbutton S1.



Victor Erdstein,
Highett, Vic. ($25)



Model theatre lighting dimmer

This circuit is the basis for the dimmers in a model theatre lighting system which uses torch globes as the light source. The circuit is based around a 555 timer (IC1), driving a Triac.

All dimmers share the one power supply and zero-crossing detector. As it will only work if there is a common AC/DC return path, it has a simple DC supply circuit consisting of one 1N4004 diode and one 4700µF capacitor.

Transistors Q1-Q3 comprise a zero-crossing detector whose output is inverted into a negative-going pulse by Q4. This pulse is fed to the trigger input (pin 2) of the 555 IC which then starts its timing period at the beginning of each mains half cycle.

The length of this period is set by a 220nF capacitor, a 1kΩ resistor and trimpots VR1 and VR2. The output of IC1 at pin 3 is then fed to transistor Q5 which inverts this signal to trigger the Triac via a 100Ω resistor.

When the timing period is short, the Triac is turned on early in each half cycle and the lights are bright. Conversely, when the timing period is longer, the lights are dim or turned off. The main dimmer control is potentiometer VR1.

Trimpot VR2 is used to set the range of VR1. With VR1 set fully clockwise (ie, maximum resistance), trimpot VR2 is adjusted until the lights are just turned off. The lights should then be able to be faded over the full range by the control potentiometer.

Barry Freeman,
Morphett Vale, SA. ($40)

CONTRIBUTE AND WIN!

As you can see, we pay good money for each of the "Circuit Notebook" contributions published in SILICON CHIP. But now there's an even better reason to send in your circuit idea: each month, the best contribution published will win a superb Peak Atlas LCR Meter valued at $195.00.

So don't keep that brilliant circuit secret any more: sketch it out, write a brief description and send it to SILICON CHIP and you could be a winner!

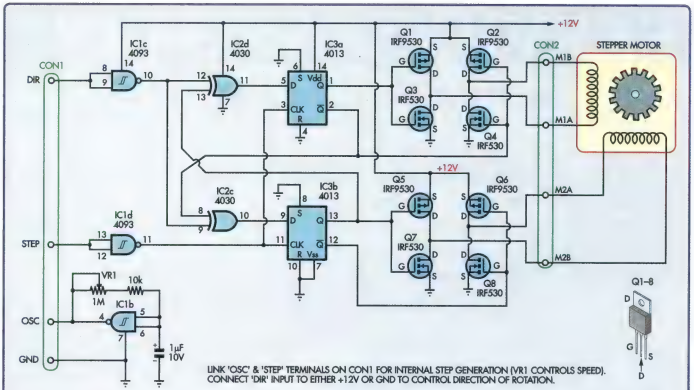
You can either email your idea to silchip@siliconchip.com.au or post is to PO Box 139, Collaroy, NSW 2097.

Fully adjustable power supply

Based on a National Semiconductor application note, this circuit uses an LM317 3-terminal regulator (REG1), chosen because of its built-in over-current and over-temperature protection. Its output is boosted up to just over 5A by the MJ2955 transistor (Q1).

The output voltage is varied by adjusting the voltage on REG1's ADJ terminal using VR1 (a 10kΩ potentiometer), via the 270Ω resistor.

Adjustable current limiting is provided by op amp IC1, used as a comparator, which monitors the voltage across the 0.1Ω current sensing resistors. Once this voltage



4-wire stepper motor driver

This circuit enables the 6-wire stepper motor driver circuit from the May 2002 issue of SILICON CHIP to drive a 4-wire stepper motor, which is widely available in scrapped Epson or Cannon inkjet printers. A 4-wire stepper motor requires bi-directional current drive which is provided by adding four P-channel IRF9530 Mosfets to the original circuit to form two H-bridge driver circuits. The original circuit's IRRZ44Ns can be replaced with IRF9530s.

Note that the input voltage applied to the circuit should be about 12V. If a higher voltage is required, a separate driver for each Mosfet may be needed.

Paul Chen,
Eastwood, NSW. ($35)

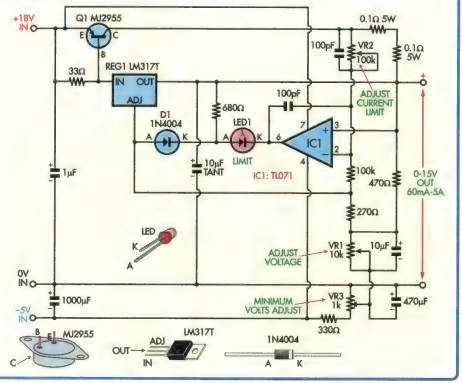
exceeds a level set by potentiometer VR2, then its output goes low, dragging down the adjust pin of REG1 and thus the output voltage. LED1 illuminates when current limiting is occurring.

The 10kΩ voltage adjust potentiometer (VR1) has one side connected to -5V instead of 0V so that the output voltage can be varied down to 0V instead of 1.2V (normal limit of an LM317). Trimpot VR3 is adjusted to set the minimum output voltage to +100mV or so.

Note that because the -5V rail is used as a reference, it should be regulated using an LM7905 or similar.

The LM317 3-terminal regulator and Q1 should be mounted on the same heatsink to take advantage of REG1's thermal control.

Philip Chugg,
Rocherlea, Tas. ($40)



SERVICEMAN'S LOG

It's been a Panasonic month

I've got quite a mixed bag this month but (fortunately) most of the faults were fairly straightforward. However, it's amazing how some common faults can come back to haunt you in different guises!

A brand-new 2003 Panasonic TX-68PS72A (MX12 chassis) requiring urgent warranty attention appeared on my bench. The set wouldn't start but the +141V, +15V, +12V, +9V, +5V and +3.5V rails were all being delivered by the primary switchmode power supply and were apparently all reaching their correct destinations.

There was also +141V on the collector of the line output transistor (Q551, 2SC5517000LK) and on the horizontal driver transistor Q541, which told me that the latter wasn't being switched on. This was due to the fact that no pulses were coming from pin 19 of the jungle IC (IC601, C1AB00001715). I then checked the voltage rails going to IC601. In this case, there should be +5V to pins 11, 42 and 74; and +9V to pins 25, 67 and 45. The latter (ie, to pin 45, HVCC) is the all-important +9V rail for the horizontal oscillator. This is derived from the 12V rail but measured just 4V on the actual pin.

A close inspection of the circuit revealed that the +12V rail is fed through two very special diodes – D401 & D402 – and then a small choke (L401). These diodes, type MA2C029WAF, are called "Diode Varistor Double 1.24V" and the only trouble was that D401 had 6.76V across it instead of only 1.24V. A new diode restored the voltage and the set then functioned properly.

The streaky TX- 68P100Z

Mrs Staples' 3-year old Panasonic TX-68P100Z flat screen TV (MD2 chassis) had an horrendous picture, with incredible 8cm streaking after every object on the screen. In fact, at first glance it looked as though it was some deliberate digital effect. The streaking wasn't confined to any particular colour but could be varied slightly with the contrast control.

Well, I checked the digital board by substitution and I could see, on the oscilloscope, that the RGB waveforms going into the three output ICs on the CRT "L Board" were clean. However, they were decidedly crook going to the CRT cathodes. I checked for ripple on the +140V and 210V rails to the three ICs and they were fine but the 12V was a different story.

At this point, my attention was grabbed by a 3-pin device that's normally used in low-voltage switchmode power supplies. This device is a TL431CLP zener linear IC controller and, in this unit, is designated D354. It is fed with 2.5V from pin 1 of each of the three output ICs and controls the 12V rail via R387, a 470Ω resistor.

This circuit is designed to protect the rest of the set from CRT flashover by shorting the 12V rail and causing the set to shut down. However, in this instance, a partial failure in D354 had caused these symptoms. A new one fixed the problem.

Items Covered This Month

- Panasonic TX-68PS72A TV (MX12 chassis)
- Panasonic TX-68P100Z TV (MD2 chassis)
- Sanyo C29PK81 TV (AA1-A29 chassis)
- Philips VR788/75 Hifi VCR
- Panasonic TC-68V80A TV (MX-4M chassis)
- Philips 29PT9418 TV (MG3.1 chassis)

Faults that haunt

It's amazing how some common faults come back to haunt you in different guises!

Mr Cabezas was complaining about his Sanyo C29PK81 (AA1-A29 chassis) and was waffling on about the colour being "wrong" and "going funny". Now, having been in the trade for far too long, I "kinda" switch off when people waffle on about symptoms in their TV sets, as most are incredibly poor in describing what they see.

For example, back in the early 1950s when RCA was developing colour TV in the USA, the public was invited to examine a whole row of colour TV prototypes in a large corridor and grade the quality of the pictures according to various subjective criteria. One of the sets was not a TV set at all – it was just a window looking outside onto a garden. 60% of the people who filled in the questionnaire ticked that the picture was poor and the colour unnatural!

Many people use the word "unwatchable" when describing picture faults. Does this mean that they are blind? In fact, some 10% of the population is colour blind and about half of them don't even know it. So I guess it's just you and me who really know what good colour is all about . . . and I am beginning to wonder a bit about you!

Anyway, I told Mr Cabezas to bring his TV in, whereupon he promptly wedged the heavy set into the back seat of his Falcon and, judging by the time he took to arrive, drove it around on two wheels! If the set hadn't been damaged before, both it and the car certainly were now.

Finally, we got it onto my work-

THE SET EMPLOYS WHAT LOOKS LIKE A REALLY WEIRD CIRCUIT TO SPLIT THE COLOUR AND LUMINANCE...

bench and I hooked it up to an antenna and looked at the picture. He was dead right – the picture was . . . well, funny. It was intermittently dark, sometimes going negative and with the colours appearing to split as though the static convergence was being adjusted. That said, it really is hard to accurately convey the effect on the picture.

OK, so where should I start? While I was thinking and dithering about this, the picture became so dark that it eventually "went out" altogether. Great, out of the frying pan into the fire. Had the picture tube gone? No; it was still there!

After I had recovered from my panic attack, I decided to work from first principles. What did I have? Well, for starters, stereo sound. In addition, the filaments of the tube were alight and there was no smell of burning. "Wonderful", I thought. "It can't be that bad".

Using a multimeter, I found that there was bags of screen voltage on the G2 grid of the tube. However, the collectors of the output transistors (and thus the cathodes) were all high at nearly 200V, which meant that these transistors were well and truly switched off.

To check the CRT, I chose one hapless cathode and momentarily shorted it to ground. This gave a fully scanned raster of bright colour, so I now knew that the set's vertical and horizontal scanning and EHT were all OK. What more could Mr Cabezas want? Well, a good picture would be nice, I suppose.

Fortunately, by now, a few bells were beginning to ring. And then I remembered – of course, it was just had to be resistor R1792 (120kΩ), which biases all three output transistors from the 200V rail.

Well, that fixed the problem and I mentally kicked myself for not remembering this rather well-known fault. I guess there is no fool like an old fool! I also replaced R485 (180kΩ) for good measure, as it can also give weird dark picture problems.

Mr Cabezas arrived to collect his set almost immediately, forcing it "none too gently" back into his long-suffering Falcon and disappearing in a cloud of blue tyre smoke.

Philips hifi VCR

The main worry with blown switch-mode power supplies is that you have diagnosed and replaced every faulty component, and determined (if only roughly) why it blew up in the first place, before switching it back on.

Recently, I had a 1999 Philips VR788/75 Hifi VCR brought in after a block of units was struck by lightning. Unfortunately, Mr Ford was an old age pensioner and did not have household contents insurance, so he was faced with either buying a new one or getting the old one fixed. And while he could buy a cheap mono VCR, watching movies was his only pastime and indulgence and so he chose to get his hifi VCR fixed.

When I removed the cover, I could see that the power supply on the right of the 2-piece board was severely damaged – even the optocoupler's plastic case had exploded! At this stage, my main concern was whether this was mainly a mains-borne lightning surge or a surge that had also come through the aerial socket. If it was the latter, then the tuner could also be U/S which, combined with the damaged power supply, would make it too expensive too fix.

My next step was to dismantle the entire unit to get the motherboard out. As I did so, I examined it very carefully, looking for telltale black marks, but none could be found. So far so good!

Getting back to the power supply, fuse FS001 was now just a few encrusted black shards of glass protruding from the metal end-caps. In addition, 0.39Ω resistor R5106 had a black hole in its side, while the 2SK2632 FET had lost its face, as had optocoupler PC5101, transistor Q5102 (2SD2144S) and transistor Q5302 (2SC1740S).

This lightning hit had been violent, although ironically had not affected the TV set which was still merrily working.

Having removed the five obviously-damaged components, I used a multimeter to check some of the other parts in the power supply. This quickly showed bridge rectifier D5001 to be short circuit and so I continued to

check all the remaining active components, including the diodes. Because of the severe damage to the optocoupler, I was concerned that the surge had also taken out every single active component on the secondary (cold) side of this device. Despite this, I couldn't find anything else that was faulty.

Before ordering new parts, I checked a pile of similar wrecked Philips VCRs I had stored – mostly mono VR299/75 models. However, pickings were minimal – most had found their way to this, their last resting place, because of similar component failures. Acting on a whim, I decided that I would choose one of these and rebuild its power supply too – after all, the parts were very similar and it was just as easy to order for two as for one.

When the order arrived, I changed all seven parts for the VR788 and only the four I felt were required for the VR299 – ie, the fuse, the FET, the bridge rectifier and resistor.

Well, predictably, I had guessed correctly for the former and messed up for the latter. In retrospect, I should have replaced the same components, even though they measured OK in circuit. Mr Ford's video was now performing perfectly while the mono VR299 was chucked back onto the junk pile (after blowing away the smoke)!

Ms Hardy's service call

Ms Hardy requested a service call for her Panasonic TC-68V80A TV set (MX-4M chassis), which was dead. When I arrived, it was easy to see the reason for the set's demise. She had an absolute waterfront to the Pacific Ocean and electricity and sea air just do not mix well.

The set was about seven years old and was pretty rusty. Unfortunately, I had the temerity to suggest that it was past its use-by-date, especially in this environment. Miss Hardy soon put me right on that score and I was ordered to take it away and "jolly well fix it, my man"!

After nearly killing myself by carrying the set down the stairs to the visitors' carpark area about 15km away, I wasn't sure which was in worse condition – the TV or myself.

Anyway, back at the workshop, you could see the green gangrene of salt-water corrosion extending into the bowels of the set from the rear, though fortunately it had only seriously penetrated about 50mm into the components on the PC boards.

My first step was to thoroughly clean the boards, which left them looking pretty good and with only superficial damage. The brunt of the attack was on the AV H Board, which protrudes vertically (probably saving the E Board behind), and on the Power Supply P Board.

After replacing the boards, I switched the set on and was amazed to see it actually fire up and give a picture with sound. The result was somewhat intermittent, though – especially the picture width – and the power supply was making a few noises. I substituted a good power supply from another TV and everything looked pretty good, so I left it on test whilst I tackled the original power supply.

The components around IC802 HA17555 looked a bit sorry, so I set about removing and testing them. They all measured OK but I replaced zener diodes D821 (8.2V), D819 (11V), D830 (9.1V) and D831 (4.7V) just to make sure. However, I couldn't replace D836 because I didn't have one in stock.

Back in the set, the power supply was now a lot more stable but other things had started to go wrong. There was noise in the left-channel speaker, the colour was fading and there was no picture on the AV2 input. I swapped the AV (audio/video) module over and these symptoms all cleared up, so the fault was in this module.

There isn't much on the component side of the AV module except IC3001 (M51321P), transistor Q3005 and a few assorted capacitors. I socketed the IC and swapped both it the transistor but this had no effect. Surely it couldn't be the surface mounted components on the rear of the board, because these weren't facing the sea and would have been protected by the board itself?

There are three ICs and nine transistors (all surface mount devices) on the rear of the board. A quick check showed that all were being fed from the +12V supply rail, so I decided to look carefully at the symptoms and solve each problem in turn.

By now, the noisy left-channel sound had become intermittent "no-sound". All three ICs on the rear of the board are involved with AV switch-

ed IC, I checked the switching control voltage to pin 5 from Q3013. That proved to be a wise move, because it wasn't there.

R3068 and R3069 form a voltage divider to the base of Q3013 and the only voltage I could detect was on Q3013's base. But where was this phantom voltage coming from? It turned out to be Q3013 itself – it was leaky and so the transistor was switching itself on! Replacing it fixed the "no-colour" problem.

So far so good – that left the "no-picture" on AV2 problem to solve.

The AV2 switching is carried out by IC3003 and a check with an oscilloscope soon showed that the video was arriving at pin 9. However, there was no output from pin 8. Due to an error in the circuit diagram, pin 6 (the control pin) is shown disconnected whereas, in actuality it is connected to the 12V rail via R3040 (10kΩ). R3040 measured OK and there was voltage on pin 6, so I replaced IC3003 which fixed the problem (much to my relief).

By the way, I couldn't obtain the correct IC (TC4066BFN) from my local supplier, as the ones they supplied were (surprisingly) too wide! Instead, I had to order originals from Panasonic.

Despite my earlier work, the power supply was still playing up. I replaced IC802 (HA17555 – the CMOS version of an NE555 timer) to no effect. Next, I tried heating and freezing around this area and this caused some dramatic effects, often switching the power supply completely off.

Transistors Q808 and Q809 were

Ozitronics
www.ozitronics.com
Tel: (03) 9434 3806 Fax: (03) 9434 3847
Email: sales@ozitronics.com

Phone Call Logger
Record the start and stop time of outgoing calls along with any numbers dialled. 'Stand alone" operation - no need for any PC connection. No data loss during power failure. Supplied with 16K of memory - expandable to 64K. Includes plastic case 130x110x30mm.

K164 - $127.60

DTMF Telephone Relay Switcher

Call your phone number using a DTMF phone from anywhere in the world and remotely turn on/off any of the 4 relays. User settable Password, Anti-Tamper, Rings to Answer, Auto Hang-up and Lockout. Includes plastic case 130x110x30mm. 12VDC

K140 - $93.50

DTMF Tone Grabber
Detect DTMF tones direct from a telephone line or via the onboard microphone. Last 32 digits detected are stored and displayed on a 16x1 LCD. Display can be scrolled left and right. Each digit is also output as ASCII data via serial port.

K153 - $40.15

Prices include GST - shipping extra.
Full documentation available from website.

ing, while part of IC3001 is involved with the stereo sound. Using an audio probe, I could hear the TV sound arrive at pin 18 but it was low on pin 1 compared with that from the right channel on pin 9.

A glance at the circuit showed that pin 1 fed Q3001 and this transistor is muted by Q3002 on its base. I shorted the base-emitter junction of Q3002 (to turn it off) and the sound came up. I then found that freezing Q3002 made the sound come and go and replacing this surface-mounted transistor fixed the sound problem.

Next on the list was the intermittent colour problem. This was now almost a "no-colour" problem, which was good for me as I had a definite measurable fault.

The set employs what looks like a really weird circuit to split the colour and luminance, and you have to wonder why they did it that way. It involves two TC4066BFN analog switches and five transistors. It's only when you look at the "upmarket" version of this set, which uses the same board but is fully loaded with all the components that are missing from the model I was working on, that you see that the extra SVHS inputs require the switching.

I followed the signal from pin 14 of IC3001 to emitter follower Q3005 and thence to pin 3 of IC3004. However, at this point, it wasn't switching properly to pin 4, so the colour signal stopped there.

Before replacing this surface-mount-

proving to be rather sensitive, so I decided to replace them one at a time. Both proved to be intermittently internally leaky and replacing them finally fixed the power supply problem.

The only problem left was Ms Hardy. I phoned her about the considerable cost of the repair and added extra for every time she condescendingly used the term "my good man".

I am now in traction after re-delivering the set up all those flights of stairs. I certainly won't be having anything

ELAN Audio
The Leading Australian Manufacturer of Professional Broadcast Audio Equipment

2 Steel Court South Guildford
Western Australia 6055
Phone 08 9277 3500
Fax 08 9478 2266
email poulkirk@elan.com.au
www.elan.com.au

RMA-02
Studio Quality
High Power
Stereo Monitor
Amplifier

Designed for Professional Audio Monitoring during Recording and Mastering Sessions
The Perfect Power Amplifier for the 'Ultimate' Home Stereo System
For Details and Price of the RMA-02 and other Products, Please contact Elan Audio

DESPITE MY EARLIER WORK, THE POWER SUPPLY WAS STILL PLAYING UP

further to do with Ms Hardy's set if I can possibly help it!

The arcing Philips TV

A Philips 29PT9418 (MG3.1 chassis) came into the workshop with the customer complaining that it was dead! Well, it wasn't quite dead – it just wouldn't start up.

The slow start-up procedure with this set is indicated by a LED display, starting with red (standby), then green and finally yellow before the picture and sound come on. In this instance, it would go through this process but instead of giving picture and sound, the red LED would flash, indicating that the set was in "Protection Mode". Unfortunately, because I don't have the "Dealer Service Tool", I was unable to read the error code.

After removing the covers, I found that I could measure the +141V rail as it rose until the red LED started flashing, at which point it would cut off. I checked the line output transistor (Q7421, BU2520PX) and this proved to be OK. However, an oscilloscope connected to the collector of this transistor momentarily showed some ringing before the set closed down.

By now, I was satisfied that the flyback (or line output) transformer was the cause of the problem and so I started to remove it. There is a support screw from a rear panel to the transformer which has a plastic collar. When I removed this, I noticed it was carbonised on the inside.

As this set came from a beachside address, I suspected it had been arcing around the collar. Anyway, I carefully cleaned away the carbon and switched it back on. This time, success – the picture and sound came on but I could still detect the telltale hiss of arcing around the flyback transformer. A new one fixed the fault properly. **SC**

SILICON CHIP'S
Limited Stock
Electronics TestBench

Electronics TestBench **is a valuable 128-page collection of 20 top test equipment projects from the pages of SILICON CHIP.**

Includes: Power Supplies, Semiconductor Testers, Inductance Meter, Cable & Wiring Tester, Pink Noise Source, Zener Diode Tester, Crystal Checker, Sound Level Meter, Insulation Tester, Logic Probes, Low Ohms Tester, Remote Control Tester, Telephone Exchange Simulator, High-Voltage Insulation Tester.

SPECIAL PRICE: $9 (INC P&P & GST). Note: may be shop-soiled.

Order by phoning (02) 9979 5644 & quoting your credit card number; or fax the details to (02) 9979 6503; or mail your order with cheque or credit card details to Silicon Chip Publications, PO Box 139, Collaroy, NSW 2097.

March Madness

March 04 ISSUE

OVER 1,500 PRODUCTS IN STORE JAYCAR ELECTRONICS

A 2.4GHz Wireless Black & White Surveillance Camera with Infrared

Take the hassle out of installing surveillance cameras. Simply apply power and the camera will transmit the image, with audio to the receiver. It features Infrared LEDs for night monitoring. It's great for keeping an eye on sleeping children, or even the poolside action. Supplied with mains pluggacks, camera, 3 channel receiver and an AV RCA cable.

A colour version is also available. See inside for details!

Quantities are limited, so don't miss out!

Cat. QC-3255 **$129.00**

2003 Cat Price $269

SAVE $140

"Quick Brake" - Emergency Brake Light Trigger Kit

NEW KIT

Ref: Silicon Chip March 2004.
Now you can put on your brake lights even before you touch the brake pedal! It triggers when you rapidly lift your foot off the throttle, as you would to put it on the brake, so following motorists are warned that you're stopping much earlier! Works with standard throttle position sensors. Kit supplied with PCB, wire and all components.

Cat. KC-5373 **$24.95**

Glue Impregnated Heatshrink

Heatshrink is a very versatile aid in many aspects of electronics. This heatshrink takes the concept one step further, with glue already impregnated on the inside walls of the tubing. As you heat it, it will shrink, releasing the glue. It's a great aid to help keep water and dust out, or just ensure a stronger connection. All are 1.2m long and black in colour. See website for details.

3.2mm dia Cat. WH-5600 **$2.95**

6.4mm dia Cat. WH-5602 **$3.45**

7.9mm dia Cat. WH-5603 **$3.95**

9.5mm dia Cat. WH-5604 **$4.45**

12.7mm dia Cat. WH-5605 **$4.95**

19.1mm dia Cat. WH-5606 **$7.95**

NEW 2004 CATALOGUE

Yes, it's almost that time again, but we have taken an extra month to find even more great new products to make the 2004 catalogue the biggest & best yet!

OUT IN MAY

NEW STORE IN ALBURY

565 Hume St. Albury.
NSW. 2640.
Ph: (02) 6021 6788

OPENS MID MARCH
(Next to Total Tools)

OVER 1,500 PRODUCTS IN STORE JAYCAR ELECTRONICS

SENSATIONAL SURPLUS SPEAKER SCOOP

We have made this great surplus speaker purchase but they won't last long! Quantities are extremely limited, so be quick or you will miss out! There are also a range of ports, crossovers, terminals and more that are such great value, we can't list them here!

4" Shielded Mid / Bass Driver

12 Ohm impedance, coated paper cone and 92Hz resonant frequency.

Cat. CW-2160 **$5.95**

5" Shielded JENSEN Mid Bass Driver

8 Ohm impedance, coated paper cone and 53Hz resonant frequency.

Cat. CW-2162 **$8.95**

5 1/4" Shielded JENSEN Mid Bass Driver

8 Ohm impedance, coated paper cone and 65Hz resonant frequency.

Cat. CW-2164 **$9.95**

6" Shielded JENSEN Mid Bass Driver

12 Ohm impedance, coated paper cone and 37Hz resonant frequency.

Cat. CW-2166 **$14.95**

6" Mid / Bass Driver with Polyurethane Surround

8 Ohm impedance, coated paper cone and 58Hz resonant frequency.

Cat. CW-2170 **$16.95**

6" Mid / Bass Driver with Butyl Rubber Surround

12 Ohm impedance, metallic polypropylene cone and 46Hz resonant frequency.

Cat. CW-2172 **$19.95**

8" Shielded JENSEN Subwoofer with Butyl Rubber Surround

12 Ohm impedance, coated paper cone and 35Hz resonant frequency.

Cat. CW-2174 **$23.95**

8" Mid / Bass Driver with Vented Magnet Assembly

8 Ohm impedance, coated paper cone and 35Hz resonant frequency.

Cat. CW-2176 **$23.95**

8" Subwoofer with 4 Layer Voice Coil

8 Ohm impedance, metallic polypropylene cone and 35Hz resonant frequency.

Cat. CW-2180 **$29.95**

Freecall For Orders 1800 022 888

www.jaycar.com.au

Jaycar ELECTRONICS

ELECTRONICS

Faraday Hand Powered LED Induction Torch

No batteries required! To use this torch you simply shake it up and down and the internal mechanism charges a small rechargeable cell to run the LED. When the torch starts to dim, simply shake it again to restore full brightness. It is waterproof, made from strong ABS plastic and even floats in water. Never get caught with a powerless torch again! Measures 165(L) x 37(dia)mm.

Cat. ST-3340 $14.95

Kableflags - Cable Identifier Tags

These handy cable identifiers make it easier to identify cables and plugs. No more unplugging the wrong power cable from a power board. The flag simply loops around the cable and through itself, so they are re-useable. Each packet contains 10 tags and two types are available.

Blank KABLEFLAGS NEW

Suitable for any appliance. Simply write on the flag and attach.

Cat. HP-1240 $11.95

Entertainment KABLEFLAGS NEW

Pre labelled for Television x 2, VCR, DVD, Pay TV, Stereo, Game Console, Computer, Scanner and Printer.

Cat. HP-1242 $11.95

Novelty Farting Man

Endless fun for all jokers old enough to understand. This animated man turns his head, drops his pants and lets off a series of rip-roaring farts when someone passes by. Uses 3 x AA batteries, included.

Cat. GT-3100 $24.95 NEW

Willy the Flashing Man

For the Practical Joker's bar... He looks to see who's watching, then opens his coat and drops his pants while playing a great mix of tunes. Hilariously funny.

Cat. GT-3102 $24.95 NEW

Superbright SMD LEDs for Mobile Phones

These surface mount LEDs are used to illuminate the keypad and display of many popular mobile phones. They do require surface mount soldering skills to mount them, but the results are fantastic. Supplied as a pack of 6, but two packs or more may be required.

Phone not included

Blue	Cat. ZD-2020	$14.95
Pink	Cat. ZD-2022	$24.95
White	Cat. ZD-2024	$19.95

NEW

Personal Breath Analyser

Unlike many other personal alcohol detectors available, this pocket sized unit is both accurate, and easy to use. It will detect blood alcohol levels as low as 0.01%. It offers a good indication of blood alcohol levels, but should not be relied upon and you should never drink and drive.

Cat. QH-7292 $59.95

DARTS! DARTS! DARTS! DARTS! AND MORE DARTS!

Talking Electronic Dartboard

A completely automated scoring game. No messy chalk and board, there are 13 different games and handicapping! **Was $99.95**

SAVE $20

Cat. GH-1030 $79.95

Desktop Magnetic Dartboard

A great compact and safe way to enjoy a game of darts. It has magnetic tips for safety.

Cat. GH-1034 $14.95

Mini Talking Electronic Dartboard

Similar to the dartboard above, but a little more compact and simpler play options. Great for travel.

NEW

Cat. GH-1038 $29.95

Wall Mount Magnetic Dartboard

This unit has magnetic tips for safety and the board is full size. It mounts easily onto any wall.

Cat. GH-1036 $24.95

Remote Controlled Fart Machine

Simply hide the unit near your intended victim. When you activate it from a distance with the remote control, it lets out a great realistic fart noise! Not only will they be embarrassed, they won't even know who is responsible. It has 3 different fart noises, automatically selected each time the button is pressed.

Cat. GH-1088 $19.95

Farting Salt and Pepper Shakers

Entertain, or embarrass with these great novelty salt and pepper shakers. They look like ordinary shakers, which they are, but when they are tipped upside down, they let out a great realistic fart sound.

Cat. GH-1080 $19.95

Electronic Farting Keyring

This is a very simple version of the other farting devices we have. It is however, still very effective. Simply push the button and it lets off a great farting sound.

Cat. GH-1082 $9.95

Miniature Radio Controlled Battle Tanks with Sounds

Table-top tank battles have now become even more exciting with these new remote controlled replica tanks. They feature a rotating turret with realistic recoil action and cannon sound when the cannon is fired. The tanks are supplied with miniature battlefield soldiers, trees and fuel drums to complete your mini table-top war zone. Get two tanks and engage your opponent in a one-on-one tank battle. Each is supplied with its own individual remote controller.

NEW

Two types available:

Panther Tank in Jungle Camouflage Cat. GT-3046
Sherman Tank in Desert Camouflage Cat. GT-3048

Both Types (ea) $44.95

Power Dive Radio Controlled Submarine

The ultimate toy for the bathtub, pool, or fish tank. It has full manoeuvrability with forward, back, left, right and also a power dive function to dive quickly to the bottom. Fitted with an LED headlight, it can even see in the dark!

Cat. GT-3045 $29.95

Over 1,500 PRODUCTS IN STORE

Jaycar ELECTRONICS

Freecall For Orders 1800 022 888

www.jaycar.com.au

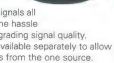
GREAT PRICES ON WIRELESS TECHNOLOGY IN MARCH

2.4 GHz Wireless AV Sender

Share your Audio/Video signals all over the house without the hassle of running cables and degrading signal quality. Additional receivers are available separately to allow multiple viewing locations from the one source.

Cat. AR-1832 **$99**

Extra Receiver



Cat. AR-1833 **$69**

2.4 GHz Wireless AV Sender with IR Remote Control Extender

Similar in design to the AR-1832 (left), with the addition of an Infrared remote control extender. This allows you to control the DVD, Cable TV, or VCR from the remote viewing location.

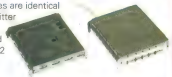
Cat. AR-1830 **$139**

Don't pay too much for Wireless AV Gear! Come to Jaycar for the BEST price in town!

Extra Receiver with IR Extender

Cat. AR-1831 **$89**

2.4 GHz Wireless AV Sender Modules



These modules are identical to the transmitter / receiver modules used in our AR-1832 Wireless AV Sender.

They are supplied in a metal case, with pin-outs and data sheets. They only require 5VDC, a few simple components and associated panel hardware (if required) to get them up and running. The transmitter and receiver modules are sold individually for greater flexibility.

Transmitter Module

Cat. QC-3590 **$34.95**

Receiver Module

Cat. QC-3592 **$49.95**

Mini Wireless CMOS Colour Camera with Audio

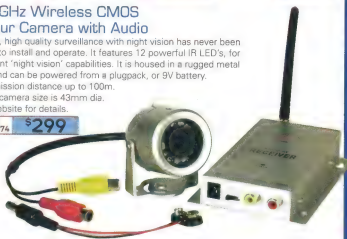
Highly covert or mobile surveillance is now very accessible with the use of this 2.4 GHz camera/receiver package. Monitor remote locations up to around 100m with video and audio capture. The camera can be plugged into mains power with the included plugpack or with a 9 volt battery attachment, also included. Actual camera size is a tiny 22mm x 22mm. See Website for details and specs.

Cat. QC-3270 **$249**

2.4 GHz Wireless CMOS Colour Camera with Audio

Simple, high quality surveillance with night vision has never been easier to install and operate. It features 12 powerful IR LED's, for excellent "night vision" capabilities. It is housed in a rugged metal case and can be powered from a plugpack, or 9V battery. Transmission distance up to 100m. Actual camera size is 43mm dia. See website for details.

Cat. QC-3274 **$299**



Infrared Wireless Stereo Headphones

Featuring a volume control, power and charging indicators and plush, fabric covered cups that fit securely around your ears for rich bass and long term comfort.

Was $79.95

SAVE $10

Cat. AA-2051 **$69.95**

2 Station Wireless Intercom

Great for communicating around your home. It works on an FM principle, which transmits via the mains connections used to power the units. Additional units can also be added.

Was $74.95

SAVE $10

Cat. AI-5500 **$64.95**

Remote Control for Central Door Locking

Wireless control of your car door locking! Wether you have factory fitted, aftermarket, or are about to install central locking, chances are this unit can be integrated. It suits almost all central locking units on the market. **Was $79.95**

Cat. LR-8831 **$69.95**

SAVE $10

2.4GHz Wireless Colour CCD Camera with Infrared Illumination

Monitoring remote locations has never been easier or cheaper with this colour transmitting camera and 3 channel receiver. The receiver will accept up to 3 separate cameras and can be set to scan and individually display each camera. Great for home security, kindergartens, factories, surgeries etc.

Supplied is a 3 channel receiver, one transmitting camera, mains plugpacks and an A/V RCA cable.

Limited stock! Don't miss out

SAVE $160

2003 Cat. Price $329

Cat. QC-3260 **$169.00**

Unidirectional Wireless Tie Clasp Microphone

Clips onto your collar or neck tie and transmits on the standard FM band to be picked up by a tuner. Works extremely well, tuneable between 88 and 108MHz – FM. **Was $32.95**

SAVE $5

Cat. AM-4068 **$27.95**

RF Wireless Weather Station

This great unit displays forecast information, inside and outside temp, time and calendar. Uses a wireless sensor so there are no messy cables.

Was $99.00

SAVE $20

Cat. XC-0295 **$79.00**

OVER 5,000 PRODUCTS IN-STORE

JAYCAR ELECTRONICS

Freecall For Orders 1800 022 888

www.jaycar.com.au

Jaycar ELECTRONICS

GREAT VALUE - MINI DIGITAL CAMERAS!!

100k Pixel Mini Digital Camera

- Measures just 60 x 43 x 17mm
- 352 x 288 max resolution
- USB Connection

Was $49.95

SAVE $10

Cat. QC-3190 $39.95

300k Pixel Mini Digital Camera

- Measures just 65 x 53 x 21mm
- Weighs just 41grams
- 640 x 480 max resolution
- USB Connection

SAVE $20

Was $79.95

Cat. QC-3192 $59.95

1.3 Mega Pixel Digital Camera

- Our highest resolution digital camera.
- Measures just 74 x 70 x 28mm.
- USB Connection.
- Supplied with handy stand.

SAVE $20

Was $99.00

Cat. QC-3194 $79

Binoculars with a Mini Digital Camera

- 640 x 480 max resolution.
- 100 sec video recording.
- 8x zoom binoculars.
- USB connection.

Was $99.95

SAVE $25

Cat. QC-3198 $74.95

128MB USB Flash Disk with MP3 Player

A USB flash memory disk and MP3 player in one! It stores up to 2hrs of MP3 music and requires no software (drivers included for Win98/SE). Includes lanyard and earphones.

Cat. GE-4000 $179.00

Great Value

Wireless Stereo FM Transmitter for Cars

Use your CD/MD/PDA/MP3 player to listen to your favourite tunes through your car's FM radio. The transmitter broadcasts quality sound quickly and easily. Simply attach to your portable audio player and tune your car stereo to the appropriate frequency range.

Cat. AR-3110 $34.95

9 Hr Digital Voice Recorder with USB Interface

A tiny digital voice recorder with high speed USB interface for your computer. It will record up to 540 minutes of voice quality audio. See website for details.

Was $209

SAVE $10

Cat. XC-0282 $199.00

Talking Photo Album

A photo album that talks! You can record up to 10 seconds of audio on each page for a lifetime of memories. It holds up to 24 standard (6" x 4") photo's.
See website for details.

Was $59.95

Cat. XC-0288 $49.95

SAVE $10

Keyring Laser Projection Clock

Not your average laser pointer! Point it at any flat surface and it will show you the time. It's like a re-invention of the pocket watch.

Cat. GH-1060 $39.95

2kg Stainless Steel Kitchen Scales

A great set of scales for the kitchen, finished in high quality stainless steel. 2 gram resolution and auto power off.

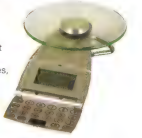
Cat. QH-7243 $69.95

Great Value

3kg Digital Nutrition Scales

Ideal for anyone on a restricted diet, or who just wants to know exactly what they are eating. These scales will display fat, cholesterol, calories, kilojoules, fibre, sodium content and even glycaemic index.

Was $79.95



Cat. QH-7240 $69.95

SAVE $10

3 in 1 Indoor Games Set

Each chess piece is a specially marked shot glass. Every time you take your opponents piece, you down the glass! It also includes two decks of playing cards and checker pieces.

Was $29.95

SAVE $5

Cat. GT-3005 $24.95

Cocktail Mixer and Accessories

Making the perfect cocktail is a snap with this unique, clear acrylic cocktail shaker. It has a handy scale for easy mixing, with six popular mixes detailed including Dry Martini, Manhattan, Red Lion and Vodka Dry.

- Supplied with accessories for six people including straws, swizzle sticks, mini umbrellas, ice blocks and coasters.
- Size: 245(h) x 100dia.)mm

Cat. GH-1152 $14.95

Shot Glass with Red LED

Just the thing to alert the bartender to fill it up again! Slam it down and the red light will flash for 15 seconds.

- Recommended to hand-wash only.

Cat. GH-1150 $3.95

Super High Power Rechargeable Halogen Spotlights

These are some of the **BRIGHTEST** halogen spotlights we have ever seen. Great for fishing, camping, 4WD'ing, these lights will be seen for kilometres! Words cannot describe just how bright these spotlights are, so drop into your local store for a look! **YOU WILL NEED SUNSCREEN FOR THESE BABIES!**

1,000,000 Candlepower

SAVE $5

- Internal 6V 4Ah SLA battery.
- Mains and car charger supplied.
- 100mm lens dia.

Was $34.95

Cat. ST-3300 **$29.95**

2,000,000 Candlepower

- Internal 6V 4Ah SLA battery.
- Mains and car charger supplied.
- 130mm lens dia.

Was $49.95

Cat. ST-3302 **$39.95**

3,500,000 Candlepower

SAVE $10

- Two internal 6V 4Ah SLA batteries.
- Mains and car charger supplied.
- 170mm lens dia.

Was $69.95

Cat. ST-3304 **$54.95**

SAVE $15

The Ultimate Pocket Knife with Pouch

Useful in many situations like tightening loose screws, removing splinters, cutting rope or even writing down quick notes.

NEW

Carry it on your belt using the canvas pouch (included).

Tool includes: Knives, Bottle opener, Screwdrivers, Scissors, Toothpick, Hook, Corkscrew, Tweezers, Pen & Pin

Cat. TH-1907 **$24.95**

12VDC Gold Fused Distribution Blocks with Voltage Display

Keep an eye on the supply voltage. They feature a 3 digit LED display to keep you informed at all times.

Wafer Style Fuse Block

1 x 2 gauge in and 2 indivually fused 4 gauge out.

Cat. SZ-2076 **$49.95**

4 Way SAG Fuse Block

2 x 4 gauge in and 4 individually fused 8 gauge out.

Cat. SZ-2077 **$49.95**

Parking Timer Keyring

Now you will always know how long you have left on the meter. It can be set up to 19hrs 59mins in 1 minute increments.

Was $9.95

SAVE $2

Cat. XC-0121 **$7.95**

Traffic Lights Parking Sensor

No more 'nudge parking' in the garage! It uses an ultrasonic sensor to measure how far away your car is and displays the lights accordingly.

Was $49.95

Cat. LR-8867 **$39.95**

SAVE $10

8 Litre Collapsible Bucket

This great 8 litre bucket collapses down to pack away, so it's ideal for camping, hiking or any situation where storage space is an issue. Supplied with a great carry pouch. Measures 255 x 35mm when folded, 255 x 230 when open.

Cat. GH-1260 **$14.95**

12V Electric Blanket

Keep warm on long distance car trips with this versatile 12V electric blanket. Made from 100% Terylene fabric, it contains a safe, low voltage heating element. Supplied with a 2.5m lead and cigarette lighter plug.

- Measures 1.5m x 1.1m.

Cat. GH-1205 **$49.95**

Electric Plastic Bag Sealer

Want to keep food items fresh? Want to protect important documents? The Handy Sealer will do the trick! In 3 seconds, the battery operated sealer heats up and seals plastic.

- Measures: 45 x 95 x 40mm.

Cat. GH-1320 **$12.95**

Keep In Touch - Without Calls, Without Wires!

40 Channel UHF CB Band Transceiver

Covers Australian 40 UHF CB channels and repeaters. Up to 5km range, no licence required.

Up to 5km Range

Cat. DC-1010 **$49.95**

69 Channel UHF Handheld Transceiver

Operating on the 433MHz band, it will work with a 1km range and no licence is required.

Was $49.95

SAVE $10

Cat. DC-1020 **$39.95**

40 Channel UHF CB Band Transceiver with CTCSS Sub Channel Calling

CTCSS allows multiple users to operate in mute mode, only responding to call tones from users with the same CTCSS setting. Up to 5km range, no licence required.

Sub Channel Calling

Cat. DC-1030 **$79.95**

40 Channel 1.5W UHF CB Band Transceiver

Up to 8km line of sight range!!! A host of professional features – with the benefit of massive transmission range! It can also be used in low power mode to conserve battery power. No licence required.

Maximum Legal Power

Cat. DC-1040 **$119**

Turbo Camping Shower

Add a touch of luxury to that outback adventure. Use a bucket of warm water and your vehicles battery and enjoy a shower no matter how far from civilisation you are.

Was $27.50

SAVE $5

Cat. YS-2800 **$22.50**

7" TFT LCD Colour Monitor for Cars

Watch high resolution pictures in widescreen format. A truly versatile monitor with low power consumption, wide viewing angle, NTSC and PAL compatibility. Includes IR remote control

Cat. QH-3752 **$399**

OVER 5,000 PRODUCTS IN STORE

JAYCAR ELECTRONICS

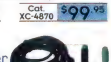
VGA to Composite Video Converter

NEW

This handy device allows you to use your television as a computer monitor. No software is required so installation is easy. Most common applications are to play DVD movies via your PC, PC gaming, presentations, education or internet viewing on TV. See website for details.

Cat. XC-4870 $99.95

USB Mobile Phone Charger

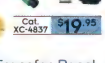


Charge your mobile from your USB port. Suits many popular phones.
Was $24.95

SAVE $5

Cat. XC-4837 $19.95

Multifunction Transfer Panel



Bring peripheral connections to the front of your PC. All hardware supplied.
Was $79.00

Cat. XC-5171 $69.00

SAVE $10

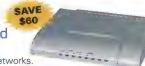
USB Data Extension Cable

5m long, up to 5 can be joined together. Full speed data transfer.
Was $34.95

SAVE $5

Cat. XC-4839 $29.95

4 Port Broadband Router



Ideal for small networks. Limited quantity.
Was $199.95

SAVE $60

Cat. YN-8090 $139.95

Multimedia Speakers and Subwoofer

16WRMS output and an excellent sound. Mains powered.
Was $29.95

SAVE $5

Cat. XC-5166 $24.95

32 Pocket DVD Wallet

Holds DVD's on one side and inserts on the other.
Was $39.95

SAVE $10

Cat. AR-1491 $29.95

Keyboard, Mouse, Monitor Lead for Switch Boxes

Colour coded D15 and PS/2 connections, 1m long.
Was $22.95

SAVE $5

Cat. WC-7570 $17.95

DATA SWITCHES

2 Way PS/2 and Monitor
Was $36.95

SAVE $5

Cat. XC-5066 $31.95

2 Way D25
Was $21.50

SAVE $4

Cat. XC-5062 $17.50

2 Way Serial Monitor **Was $31.50**

SAVE $5

Cat. XC-5063 $26.50

CD-R Pen 4 Colour Pack

Black, green, blue and red. Great value!
Was $9.95

SAVE $5

Cat. TH-3040 $4.95

PCI CARD BARGAINS

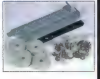
10/100Mbps Network Card
Was$16.95 Save $4
Cat. YN-8062 $12.95

2 Port USB Host Controller Card
Was $24.95 Save $5
Cat. XC-4813 $19.95

4 Port USB 2.0 Host Controller Card
Was $44.95 Save $10
Cat. XC-4817 $34.95

3 Port IEEE1394 Firewire Card
Cat. XC-4818 Was $57.95 Save $10
Cat. XC-4818 $47.95

Motherboard Hardware Kit



Replaces bits and pieces commonly lost when doing upgrades.
Was $6.70 Save $2.00

Cat. XC-4632 $4.70

3.5" Face Plate Mounting Bracket

Mounts 3.5" devices into a 5.25" bay.
Was $8.95 Save $2.00

Cat. XC-4630 $6.95

Too Hot To Print

Our Memory Card prices are too hot to put on paper. Drop into any store or see our website for the latest prices.

MOD's FOR YOUR PC!

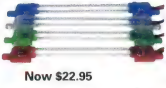
CCFL Lighting Kits

SAVE $5

Encased in a clear acrylic housing, these tubes are a great addition to any PC. Use them in conjunction with window kits and other lights for a truly spectacular effect. They require 12VDC, two sizes and five colours are available.

100mm Cat No.
White SL-2870
Red SL-2871
Blue SL-2872
Green SL-2873
UV SL-2874
All types (ea)
Was $27.95 Now $22.95

300mm Cat No.
White SL-2890
Red SL-2891
Blue SL-2892
Green SL-2893
UV SL-2894
All types (ea)
Was $39.95 Now $29.95



SAVE $10

Perspex Window Kit for ATX Cases

A 300mm² Perspex sheet. Supplied with rubber mount surround and instructions. Case not included.
Was $24.95

SAVE $5

Cat. XC-4638 $19.95

80mm Clear Fan with LEDs - 3 Wire

12VDC. Red, Green and Blue LEDs shine through the transparent body. Tacho output.
Was $19.95

SAVE $5

Cat. XC-5059 $14.95

"Knightrider" 7 LED Scanners

Multiple flashing patterns and speeds.

SAVE $5ea

Red
Was $24.95 Cat. LA-5090 $19.95

Blue
Was $29.95 Cat. LA-5091 $24.95

Dual LED 12V Flashers

These can be wired various ways to offer multiple flashing patterns, or be permanently on. Three colours available:

Red
Cat. LA-5086
Was $14.95 Now $9.95
SAVE $5

Orange
Cat. LA-5087
Was $14.95 Now $9.95
SAVE $5

Blue
Cat. LA-5088
Was $18.95 Now $12.95
SAVE $6

Jaycar ELECTRONICS
Freecall For Orders 1800 022 888
www.jaycar.com.au

GREAT SAVINGS ON SERVICE AIDS & TOOLS!

Self Amalgamating Tape

Seal and waterproof joins and cables.
- Chemical and corona resistant.
- 10m roll.

Was $22.50

SAVE $5

Cat. NH-2826 **$17.50**

Double Sided Tape

Mount PCBs, hang posters etc.
- 12mm x 1mm tape.
- 2m roll.

Was $4.95

SAVE $1

Cat. NH-2820 **$3.95**

25% Silver Heatsink Compound

Much better heat transfer than regular compounds.
- 1.5g syringe. Caution: Silver heatsink compound does conduct electricity.

Was $4.95

SAVE $1

Cat. NH-2013 **$3.95**

Liquid Electrical Tape / Thread Locker

Simply apply and allow to dry.
- Acid and salt resistant.
- Use it as versatile insulation, or to stop screws loosening etc.
- Available in 118mL cans and 28g tubes.

SAVE $5

118ml cans

Black Cat. NH-2832

Red Cat. NH-2834

Both Colours **$14.95ea**

Was $19.95

28g tubes

Black Cat. NH-2836

Red Cat. NH-2838

Both Colours **$9.95ea**

Was $12.95

SAVE $3

Screwdriver Helper

Dramatically increases the amount of torque you can apply to a damaged screw head etc. 14g in a plastic bottle.

Was $13.95

SAVE $3

Cat. NH-2830 **$10.95**

FIX-LOCK Anaerobic Adhesive

- Secure nuts and screws with this excellent thread locking compound.
- Chemical resistant.
- 7g in a plastic bottle.

Was $6.95

SAVE $2

Cat. NA-1502 **$4.95**

3 Second Super Glue

- Suitable for plastic, wood, metal, glass, rubber and ceramics.
- 3g in a small tube.

Was $1.90

SAVE $0.50

Cat. NA-1500 **$1.40**

Light Duty Hook-Up Wire Pack

8 x 25m rolls of 13 x 0.12 tinned, insulated wire.
- White, Blue, Green, Yellow, Orange, Brown, Black and Red.

Was $29.95

SAVE $7

Cat. WH-3009 **$22.95**

Air Dust Remover

- Great for non-contact cleaning of just about anything.
- Non flammable, no residue, 250g.

Was $15.95

SAVE $3

Cat. NA-1018 **$12.95**

Spray-On Contact Adhesive

- Bonds to just about anything.
- Ideal for carpeting speaker boxes and much more.
- 400g.

Was $13.95

SAVE $3

Cat. NA-1504 **$10.95**

Silver Conductive Varnish

- Repairs PCBs, window antennas & alarm loops etc.
- 3g in a small bottle.

Was $9.95

SAVE $2

Cat. NS-3030 **$7.95**

Heavy Duty Jumper Lead Kit

SAVE $2

- Large alligator clips and heavy cable.
- 10 leads, approx. 300mm long.

Was $8.95

Cat. WC-6020 **$6.95**

Super Torque Driver Ratchet

- Accepts standard 1/4" driver bits.
- Comfortable rubber handle.

Was $13.95

SAVE $4

Cat. TD-2033 **$9.95**

25Pc Allen Key Set

- 25 different imperial and metric sizes.
- Supplied in a handy plastic wallet

Was $9.95

SAVE $2

Cat. TD-2052 **$7.95**

Tapered Reamer

- Enlarge and shape holes in plastic, thin metal and wood. Suits 3-12mm holes.

Was $14.50

Cat. TD-2130 **$10.00**

SAVE $4.50

PCB Holder

- Great soldering aid.
- Sturdy cast iron base for stability.

Was $10.95

SAVE $3

Cat. TH-1982 **$7.95**

Nibbling Tool

- Cut any shape out of aluminium, plastic, copper and other unhardened metals up to 18gauge.

Was $22.95

SAVE $5

Cat. TH-1768 **$17.95**

4 Piece Countersink Set

- 90° countersunk angle.
- Use with a drill or the hand tool included.

Was $11.95

SAVE $3

Cat. TD-2027 **$8.95**

6" Insulated Side Cutters

- Designed for dedicated wire cutting.
- 1000VAC rated handles, GS approved.

Was $18.95

SAVE $4

Cat. TH-1985 **$14.95**

6.5" Long Nose Pliers

- Great pliers, also cut up to 4mm electrical wire.
- 1000VAC rated handles, GS approved.

Was $15.95

SAVE $3

Cat. TH-1986 **$12.95**

7" Bull Nose Pliers

- Strong, tough and reliable.
- 1000VAC rated handles, GS approved.

Was $23.95

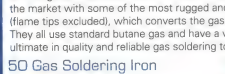
SAVE $6

Cat. TH-1984 **$17.95**

portasol® Gas Soldering Tools

Jaycar is serious about quality and soldering products are no exception. We have searched the globe for reliable gas powered soldering products and the result is what you see on this page. A leading brand recognised worldwide, their quality is second to none. Portasol products are designed and manufactured in Ireland, to the highest quality standards. Since commencing operation in 1983, they have forged their way into the market with some of the most rugged and reliable gas powered soldering and heating tools in the world. They utilise catalytic combustion (flame tips excluded), which converts the gas flame into infrared radiation. It is a safe, flameless way of heating the tips evenly and continuously. They all use standard butane gas and have a variety of tips available (see website for details) to support a wide range of applications. For the ultimate in quality and reliable gas soldering tools, you can't go past Portasol.

50 Gas Soldering Iron



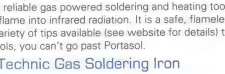
The Portasol 50 is designed specifically with the dedicated DIY enthusiasts in mind. Powered with standard butane gas, it has a run time of around 30 minutes. Ignition is via the flint ignitor in the cap and tip temperature reaches an impressive 350°C. It is fixed temperature, with equivalent electrical power of around 35W. It features automatic shut-off when the end cap is replaced and fast refill time. It is a quality tool, sure to give you many years of trouble free operation.

Specifications:

- Operating Time: 30 min (approx).
- Refill Time: 10 sec (approx).
- Ignition: Flint ignitor in end cap.
- Dimensions: 196(L) x 26(W) x 19(D)mm.
- Weight: 60g without gas.

Cat. TS-1300 $39.95

Technic Gas Soldering Iron



The Portasol Technic combines compact power and convenient reliability, making it one of the most versatile gas soldering irons available. It offers a run time of around 60 minutes and tip temperature is adjustable up to 450°C. With equivalent electrical power of between 10 and 60 Watts, it is ready to tackle just about anything. The protective end cap features a built in flint type ignitor and if the gas is left on, it will turn it off when replaced. If a compact, versatile and reliable gas iron is what you're after, then the Portasol Technic is for you.

Specifications:

- Operating Time: 60 min (approx).
- Refill Time: 10 sec (approx).
- Ignition: Flint ignitor in end cap.
- Dimensions: 170(L) x 19(Dia)mm.
- Weight: 60g without gas.

Cat. TS-1305 $59.95

Gas Powered Glue Gun

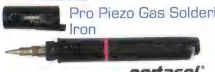
A quality, butane powered hot glue gun that can be used almost anywhere. The gun features easy push button piezo electric ignition so you don't have to fumble with matches and a translucent fuel tank that lets you see how much gas is left. The glue will bond to most household materials including ceramics, metal, fabric, leather, wood and plastics. Uses standard glue sticks available everywhere.

Specifications:

- Operating Time: 2 Hrs (approx).
- Heat Up Time: 3 min (approx).
- Ignition: Internal Piezo crystal ignitor.
- Weight: 200g without gas.

Cat. TH-1330 $69.95

Pro Piezo Gas Soldering Iron



The Portasol Pro Piezo is a powerful gas soldering iron, featuring an adjustable temperature control allowing soldering tip temperatures up to 580°C. With equivalent electrical power of between 15 and 75 Watts, there is little that's not possible this beauty. It incorporates a viewing window at the end of the gas tank, to keep an eye on the fuel level. The fuel tank fills in around 20 seconds and will provide approximately 45 minutes of run time. Ignition is via the built in Piezo crystal mechanism and the end cap provides safety gas shut off when replaced. The Portasol Pro Piezo is a dream to use and will not let you down. Supplied with a 2.4mm double flat tip.

Specifications:

- Operating Time: 45 min (approx).
- Refill Time: 20 sec (approx).
- Ignition: Internal Piezo crystal ignitor.
- Dimensions: 178(L) x 22(Dia)mm.
- Weight: 75g without gas.

Cat. TS-1310 $89.95

MARCH BONUS! Buy any of our great new Portasol tools and receive a can of butane gas (NA-1020) absolutely FREE!

Super Pro Gas Soldering Iron

The Portasol Super Pro is the big brother of all irons in the range. It features adjustable tip temperature up to 580°C, with equivalent electrical power of between 25 and 125W! 125W may seem somewhat excessive to some. You don't need a V8 to drive around town, but it's nice to know that the power is there when it's needed, isn't it? Ignition is achieved with the internal Piezo crystal mechanism and run time is around 2 hours on a 30 second refill. The stainless steel finished gas tank features a viewing window to keep an eye on fuel level and the protective end cap also acts as a safety cut off for the gas valve control when replaced. With the various tips available and huge power at hand, no job is a match for the Portasol Super Pro.

Specifications:

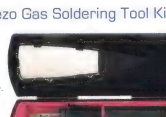
- Operating Time: 120 min (approx).
- Refill Time: 30 sec (approx).
- Ignition: Internal Piezo crystal ignitor.
- Dimensions: 234(L) x 25(Dia)mm.
- Weight: 135g without gas.

Cat. TS-1320 $109.00

portasol® Pro Piezo Gas Soldering Tool Kit

This kit contains a Portasol Pro Piezo Gas Soldering Iron and all of the following parts.

- Quality storage case.
- Cleaning sponge and tray.
- 2.4mm double flat tip (TS-1312).
- Hot air blow (TS-1314).
- Hot knife tip (TS-1315).
- Hot air deflector.
- Flame tip (TS-1316).

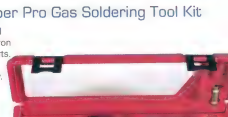


Cat. TS-1318 $119.00

portasol® Super Pro Gas Soldering Tool Kit

This kit contains a Portasol Super Pro Gas Soldering Iron and all of the following parts.

- Quality storage case.
- Cleaning sponge and tray.
- 2.4mm double flat tip (TS-1322).
- 4.8mm double flat tip (TS-1323).
- Hot air blow (TS-1324).
- Hot knife tip (TS-1325).
- Hot air deflector.



Cat. TS-1328 $149.00

Non Contact Digital Thermometer with Laser Sighting

Accurate temperature measurement without making contact is now simple. Temp range is -50 to +500°C +/-2%.
Was $159.50

SAVE $20

Cat. QM-7222 **$139.50**

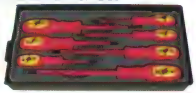
100W Soldering Gun with Pilot Light

Reaches full temp. in seconds. It is ideal for large work where there is a lot of heat dissipation. See website for details.
Was $24.95

Cat. TS-1425 **$19.95**

SAVE $5

1000V - 7 Piece Screwdriver Set



GS and DVE tested and approved to 1000V. They feature red rubber grip handles and insulation right to the tip.

Cat. TD-2022 **$19.95**

Precision Mini Metal Lathe Deal

Industrial quality on a hobby budget! Small hobby lathes are not new, they have been European made and very expensive, or have welded frames and are flimsy. This fantastic unit has a FULL cast iron bed frame and headstock assembly, just like industrial lathes.
It bristles with safety features including a plastic chuck cover which must be down for the machine to operate. This prevents you from starting the lathe with the chuck-key in!
We have not seen a product of this quality at this price.

$107.80 worth of parts already included!

The cutting tools, drill chuck and live centre are all usually sold extra, costing over $100 more, but are included in the price!!!

Cat. TL-4000 **$899.00**

Optional Extra Floor Stand

Cat. TL-4002 **$89.95**

Replacement Parts Available:

(All of these parts are already included in the deal)

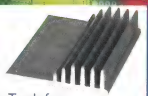
5 Piece Cutter Set	Cat. TL-4004	$29.95
Tailstock Chuck and Shank	Cat. TL-4006	$34.95
Rolling Centre	Cat. TL-4008	$32.95
Headstock Centre	Cat. TL-4010	$9.95

Optional Parts Available:

Note: These parts are not in stock at all stores, but can be easily ordered in for you.

4 Jaw Chuck NEW	Cat. TL-4012	$110.00
Face Plate	Cat. TL-4014	$39.95
Horizontal Slider	Cat. TL-4018	$150.00
Vertical Slider	Cat. TL-4020	$132.00
Thread Cutting Tool Kit	Cat. TL-4016	$19.95

Experimenters Heatsink



We landed these useful heatsinks as a surplus at a great price, so get them while they last! They're great for prototypes, made of Aluminium and are useful for a number of applications. Measures 110(L) x 87(W) x 13(fins)mm. Limited Quantity.

Cat. HH-8562 **$4.95**

'Press n Peel' PCB Film

One of the simplest ways to make PCBs from CAD software or magazine PCB artwork. Simply Print, Iron, Peel and Etch. See website for details.
Was $34.95

SAVE $5

Cat. HG-9980 **$29.95**

Etching Tank for Printed Circuit Boards

Great for etching PCBs up to 200 x 250mm. A heater and agitator could be added for increased etching accuracy. See website for details.
Was $49.95

SAVE $10

Cat. HP-9530 **$39.95**

Save 15% on Sealed Die-Cast Aluminium Boxes

64 x 58 x 35mm Cat. HB-5030
Was $8.90 **Now $7.56** SAVE $1.34

115 x 65 x 30mm Cat. HB-5036
Was $13.50 **Now $11.47** SAVE $2.03

115 x 65 x 55mm Cat. HB-5040
Was $16.00 **Now $13.60** SAVE $2.40

115 x 90 x 55mm Cat. HB-5042
Was $17.50 **Now $14.87** SAVE $2.63

171 x 121 x 55mm Cat. HB-5046
Was $34.95 **Now $29.70** SAVE $5.25

222 x 146 x 55mm Cat. HB-5050
Was $36.95 **Now $31.40** SAVE $5.55

10MHz Velleman Handheld LCD Oscilloscope

The Velleman Handheld Oscilloscope is a complete, portable unit, all at the size and cost of a good multimeter. Features include a high contrast LCD with wide viewing angle, full automatic setup, true RMS and sound level measurement. See our website for full details.
Was $349

Cat. OC-1916 **$309.00**

Save $40

10MHz Single Trace Budget CRO with Probe

This unit is ideal for the professional or dedicated enthusiast, who only needs the occasional use of a CRO. It features a powdercoated steel case, 75mm CRT with 5mm square graticule and more. It has standard sensitivity of 5V/DIV to 5V/DIV,with sweep from 0.15uS/DIV to 0.15S/DIV. See website for details.
Was $379.00

Cat. OC-1910 **$329.00**

Save $50

Hung Chang 20MHz Dual Channel, 4 Trace Oscilloscope

A great dual channel oscilloscope designed for the professional and enthusiast alike. Housed in a pressed steel cabinet with heavy duty feet and comprehensive control panel, it is a great, high quality unit. It features a large 6" screen, zero parallax graticule to eliminate reading errors, TV sync for stable synching of video signals and high sensitivity input amplifiers for measurement down to 1mV/div. See our website for a huge list of features and specifications.
Was $799.00

Cat. OC-1908 **$699**

Save $100

OVER 5,500 PRODUCTS IN STORE

Jaycar ELECTRONICS

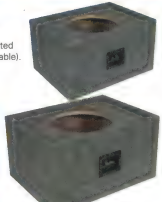
Pre-Built Subwoofer Enclosures

These subwoofer enclosures are made from 15mm quality particleboard and are supplied fully assembled. They are covered in grey carpet, have pre-cut speaker holes, gold plated speaker terminals and ports already mounted (where applicable). See our website for more details and driver / enclosure recommendations. Stocks are limited, don't miss out!

10" Enclosures Were $59.50 **Now $39.50**
10" 25L Sealed Enclosure Cat. CS-2520 SAVE $20
10" 25L Ported Enclosure Cat. CS-2521

12" Enclosures Were $75.00 **Now $50.00**
12" 35L Sealed Enclosure Cat. CS-2522 SAVE $25
12" 35L Ported Enclosure Cat. CS-2523

15" Enclosures Were $89.50 **Now $59.50**
15" 45L Sealed Enclosure Cat. CS-2524 SAVE $30
15" 45L Ported Enclosure Cat. CS-2525



Prices SLASHED on Car Noise Filters!

Eliminate annoying interference and buzzing which can make their way into your car stereo system. There are a range of sizes available to suit many different sized applications. See website for details.

5A Noise Filter
Cat. AA-3072 Was $13 **Now $10** SAVE $3

10A Noise Filter
Cat. AA-0235 Was $18.25 **Now $13.25** SAVE $5

20A Noise Filter
Cat. AA-3076 Was $22.50 **Now $14.50** SAVE $8

40A Noise Filter
Cat. AA-3081 Was $29.95 **Now $19.95** SAVE $10

Front / Rear Fader Control

Complete front / rear control over the sound balance within your car. It accepts a stereo signal and has an out of two stereo signals, which are controlled via the knob.
Was $19.95

Cat. AA-0485 $14.95 SAVE $5

6.5" RESPONSE Kevlar Split Speaker System

•50WRMS Power Handling (80W Max). •55Hz – 20kHz Frequency Response. •4 Ohm Impedance.
Was $179.00

SAVE $20

Car Stereo High to Low Level Converter

This is used when you have an amplifier with RCA sockets in, but your head unit only supplies speaker level outputs.
Was $23.95

SAVE $7
Cat. AA-0480 $16.95

Save on High Current Power Cable

8 Gauge – Up to 56 Amps
Red Cat. WH-3060
Black Cat. WH-3062 SAVE $1.00/m
Both 8GA (ea/m) Was $2.75 Now $1.75

4 Gauge – Up to 110 Amps
Red Cat. WH-3064
Black Cat. WH-3066 SAVE $1.50/m
Both 4GA (ea/m) Was $6.50 Now $5

2 Gauge – Up to 160 Amps
Red Cat. WH-3070
Black Cat. WH-3072 SAVE $3.00/m
Both 2GA (ea/m) Was $12.95 Now $9.95

Cat. CS-2298 $159.00

High Current DC Circuit Breakers

Rugged and reliable devices, suitable for car audio & any high current DC application up to 24VDC. Two versions available.
70A - Cat. SF-2265
100A - Cat. SF-2266
Was $22.95

SAVE $3
Both Types $19.95ea

Car Audio Wiring Kit

This kit has all the electrical wire, speaker cables, connectors, screws and lugs required to install most systems and will support power ratings up to 100W. It contains:
•10m speaker cable. •5m red 10 gauge power cable with 30A inline fuse. •1.2m black gauge power cable. •5m blue remote wire. •5m stereo screened RCA cable. •An assortment of screws, connectors etc.
Was $44.95

SAVE $20
Cat. AA-0440 $24.95

10" Polycone Subwoofer

•Power Handling: 200WRMS. •Impedance: 4ohm. •Sens:88dB, 1W@ 1m. •Resonant Freq: 32.8Hz.
Was $139
PROFILE
SAVE $40
Cat. CS-2360 $99.00

12" Polycone Subwoofer

•Power Handling: 250WRMS. •Impedance: 4ohm. •Sens: 90.2dB, 1W @ 1m. •Resonant Freq: 32.5Hz.
Was $169
PROFILE
SAVE $50
Cat. CS-2362 $119.00

10" RESPONSE Metal Coated Cone Subwoofer

•Power Handling: 250WRMS. •Impedance: 2 x 2ohm voice coils. •Sens: 87.2dB, 1W @1m. •Resonant Freq: 23.7Hz.
Was $199
SAVE $60
Cat. CS-2366 $139.00

8" Subwoofer

•Power Handling: 100WRMS. •Impedance: 4ohm. •Sensitivity: 88.35dB, 1W @ 1m. •Resonant Freq: 35.71Hz.
Was $49.95
Venom
SAVE $10
Cat. CS-2340 $39.95

10" Subwoofer

•Power Handling: 150WRMS. •Impedance: 4ohm. •Sensitivity: 92.02dB, 1W @ 1m. •Resonant Freq: 37.53Hz.
Was $79.95
Venom
SAVE $15
Cat. CS-2342 $64.95

12" Subwoofer

•Power Handling: 180WRMS. •Impedance: 4ohm. •Sensitivity: 87.85dB, 1W @ 1m. •Resonant Freq: 31.27Hz.
Was $99.95
SAVE $20
Venom
Cat. CS-2344 $79.95

15" Subwoofer

•Power Handling: 250WRMS. •Impedance: 4 Ohms. •Sensitivity: 88.48dB, 1W @ 1m. •Resonant Freq: 25.65Hz.
Was $129.95
SAVE $30
Venom
Cat. CS-2345 $99.95

Mosfet Car Amplifiers

2 x 150WRMS
- 150WRMS x 2@4Ω
- 230WRMS x 2@2Ω
- 450WRMS x 1@4 Ω

Was $335

SAVE $40

Cat. AA-0434 **$295.00**

4 x 50WRMS
- 50WRMS x 4@4Ω
- 150WRMS x 2@4Ω

Was $249

SAVE $34

Cat. AA-0438 **$215.00**

2 x 84WRMS
- 84WRMS x 2@4Ω
- 234WRMS x 1@4Ω

Was $225

SAVE $26

Cat. AA-0432 **$199.00**

NOT AVAILABLE IN OUR SHOPS

Techstore Mail Order Specials

5" Wide Range Twin Cone Driver
6 Ohm impedance, general purpose driver.
JJ-0016 $9.95

8" JENSEN Mid/Bass Driver
6 Ohm impedance, 50Hz resonant frequency.
JJ-0015 $23.95

Speaker Terminal and 2 Way Crossover
A great product. The crossover is mounted right on the terminal.
JJ-0014 $4.95

Flared Ports!

50 x 130mm	JJ-0013	$3.50
72 x 145mm	JJ-0012	$4.50
100 x 325mm	JJ-0011	$5.50

Techstore prices in A$. Only available from Australian Techstore Mail Orders.

Some of the surplus items have such limited stock, we can't even put them in shops! Check out www.jaycar.com.au for great bargains!

NOT AVAILABLE IN OUR SHOPS

Steel Mate Car Alarms

Full Feature Car Alarm

This is our 'full house' alarm. This model includes all necessary wiring and accessories to successfully install the alarm. Alarm activated central locking and auto approach disarm functions are included for keyless entry (requires power locking kit).

Features:
- Auto approach disarm / unlock of central locking
- Anti-interference, anti-false alarm system
- Anti-burglary and anti-hijacking

What you get
- Electronic black-box controller
- 2 transmitter key-fob learning remote controls
- Shock sensor •Fused outputs
- Battery Backup Siren •Ignition cut-out relay
- Wiring looms •Foot brake trigger

Cat. LA-9005 **$199**

Extra Remote Cat. LA-9007 **$34.95**

Two Way Car Alarm with Remote Radio Pager

This unit has a paging remote control with an alarm status LCD on the keyfob. The pager function enables the alarm to communicate with the key fob at distances between 500m - 3.3km. If someone breaks into your vehicle, the key fob will tell you which part of the vehicle has been breached! If your vehicle is suitably wired, you can command the alarm to sound the siren, flash the lights and kill the engine.

Features:
- FSK technique, high stability and anti-jamming
- Sound, vibrating and visual indication of alarm status & function
- Anti-burglary and anti-hijacking

What you get
- Electronic black-box controller
- 2 transceiver key-fob learning remote controls
- Shock sensor •Fused outputs •Battery Backup Siren
- Ignition cut-out relay •Wiring looms •Foot brake trigger
- Car transmitter •Dash-mount BLUE LED warning lights
- Battery backup siren

Cat. LA-9010 **$349**

Extra Remote Control Cat. LA-9012 **$99.00**

HUGE INVERTER SALE!!!

All feature a pushbutton on/off switch, overload protection, LED power indication and electrical isolation between the battery and secondary voltages for safety. Many other units do not have this safety feature.

Pure Sine Wave

150W (300W Surge) 12VDC to 230VAC
MI-5080 Was $299 Now $249 Save $50

300W (500W Surge) 12VDC to 230VAC
MI-5082 Was $379 Now $319 Save $60

500W (1000W Surge) 12VDC to 230VAC
MI-5085 Was $499 Now $429 Save $70

1000W (1500W Surge) 12VDC to 230VAC
MI-5090 Was $1099 Now $959 Save $140

1500W (2500W Surge) 24VDC to 230VAC
MI-5095 Was $1395 Now $1195 Save $200

Modified Square Wave

100W (200W Surge) 12VDC to 230VAC
MI-5058 Was $89.50 Now $79.50 Save $10

140W (450W Surge) 12VDC to 230VAC
MI-5060 Was $109.50 Now $94.50 Save $15

300W (500W Surge) 12VDC to 230VAC
MI-5062 Was $159.50 Now $139.50 Save $20

400W (1200W Surge) 12VDC to 230VAC
MI-5064 Was $199.50 Now $169.50 Save $30

400W (1200W Surge) 24VDC to 230VAC
MI-5065 Was $199.50 Now $169.50 Save $30

600W (1500W Surge) 12VDC to 230VAC
MI-5066 Was $299 Now $249 Save $50

800W (2000W Surge) 12VDC to 230VAC
MI-5068 Was $389 Now $329 Save $60

1000W (2400W Surge) 12VDC to 230VAC
MI-5070 Was $529 Now $439 Save $90

1500W (3000W Surge) 12VDC to 230VAC
MI-5072 Was $749 Now $649 Save $100

Great Savings on Ni-MH Rechargeable Batteries

Powercell Powercell Powercell

Battery Type	Cat.	Was	1+	10+	20+
AAA 800mAh Nipple	SB-1720	$3.59	$3.15	$2.75	$2.35
AAA 800mAh Tags	SB-1722	$3.78	$3.30	$2.95	$2.55
AA 1200mAh Nipple	SB-1730	$2.95	$2.60	$2.30	$2.00
AA 1200mAh Tags	SB-1732	$3.25	$2.90	$2.60	$2.30
AA 2000mAh Nipple	SB-1706	$5.50	$5.10	$4.75	$4.25
AA 2000mAh Tags	SB-1708	$6.25	$5.50	$4.95	$4.45

Battery Type	Cat.	Was	1+	10+	20+
C 4500mAh Nipple	SB-2429	$14.95	$13.35	$11.70	$10.70
D 8000mAh Nipple	SB-2449	$19.95	$17.70	$15.70	$13.70
4/5A 1800mAh Tags	SB-1718	$7.95	$6.95	$5.95	$4.95
4/3A 3000mAh Tags	SB-1710	$11.35	$10.35	$9.35	$8.35
Sub C 2700mAh Tags	SB-2447	$7.95	$6.95	$5.95	$4.95

OVER 5,500 PRODUCTS IN STORE JAYCAR ELECTRONICS

Studio 350 - High Power Amplifier Kit

NEW KIT

Ref: Silicon Chip Jan/Feb 2004.
This fantastic new amplifier kit will deliver 200WRMS into a 8Ω load, or 350WRMS into a 4Ω load. It is super quiet, with a signal to noise ratio of -125dB(A) at full 8Ω power. Harmonic distortion is a fantastic 0.002% and frequency response is almost flat between 15Hz and 60kHz. Kit supplied in short form including PCB & all electronic components. Kit requires heatsink and +/-70V power supply.

See in store for our great deal on power supply components for this kit!

Cat. KC-5372 $175

Valve Audio Pre-Amp Kit

Ref: Silicon Chip Nov 2003.
AT LAST! A valve based preamp kit! It uses a 12AX7 valve and offers excellent performance. Kit supplied with PCBs, case, valve, ferrite cores, bobbin and clips and all electronic components. Requires 12VDC @ 250mA.

Cat. KC-5370 $89.95

These include all components for the Hi-Fi conversion described in Feb Silicon Chip

Valve Preamp Add-On Kit

Ref: Silicon Chip November 2003.
Add to KC-5370 for a stereo valve preamp. Powered from KC-5370, so no extra power is required. Kit supplied with PCB, valve and all electronic components.

Cat. KC-5371 $59.95

Full Function Smart Card Reader/Programmer Kit

Ref: Silicon Chip July 2003
This great design will program many blank Gold, Silver and Emerald wafer cards (with relevant loader software) which conform to ISO-7816 pinout standards. PC connection is via the serial port and the PCB can be powered from a plugpack, 9V battery, or your ATX power supply. Kit supplied with PCB, card socket and all specified electronic components.

•Jaycar Electronics and Silicon Chip Magazine will not accept responsibility for the operation of this device, its related software, or its potential to be used for unlawful purposes.

Cat. KC-5361 $49.95

AC/DC Current Clamp Meter Kit for DMM's

Ref: Silicon Chip September 2003.
A great low cost alternative to expensive current clamp meters. It uses a simple hall effect sensor and iron ring core setup and connects to your digital multimeter. It will measure AC and DC current and has a calibration dial to allow for any magnetising of the core. Much cheaper than pre-built units. Kit supplied with PCB, clamp, case, silkscreened front panel and all electronic components.

Cat. KC-5368 $34.95

YOUR LOCAL JAYCAR STORE

NEW SOUTH WALES	
Albury	•Ph (02) 6021 6788
Bankstown	•Ph (02) 9709 2822
Bondi Junction	•Ph (02) 9369 3899
Brookvale	•Ph (02) 9905 4130
Campbelltown	•Ph (02) 4620 7155
Erina	•Ph (02) 4365 3433
Newcastle	•Ph (02) 4965 3799
Parramatta	•Ph (02) 9683 3377
Penrith	•Ph (02) 4721 8337
Silverwater	•Ph (02) 9741 8557
St. Leonards	•Ph (02) 9439 4799
Sydney City	•Ph (02) 9267 1614
Taren Point	•Ph (02) 9531 7033
Wollongong	•Ph (02) 4226 7089
VICTORIA	
Coburg	•Ph (03) 9384 1811
Frankston	•Ph (03) 9781 4100
Geelong	•Ph (03) 5221 5800
Melbourne	•Ph (03) 9663 2030
Ringwood	•Ph (03) 9870 9053
Springvale	•Ph (03) 9547 1022
QUEENSLAND	
Aspley	•Ph (07) 3863 0099
Brisbane - Woolloongabba	•Ph (07) 3393 0777
Gold Coast - Mermaid Beach	•Ph (07) 5526 6722
Townsville	•Ph (07) 4772 5022
Underwood	•Ph (07) 3841 4888
AUSTRALIAN CAPITAL TERRITORY	
Canberra	•Ph (02) 6239 1801
TASMANIA	
Hobart	•Ph (03) 6272 9955
SOUTH AUSTRALIA	
Adelaide	•Ph (08) 8231 7355
WESTERN AUSTRALIA	
Perth	•Ph (08) 9328 8252
NEW ZEALAND	
Newmarket - Auckland	•Ph (09) 377 6421
Glenfield - Auckland	•Ph (09) 444 4628
Wellington	•Ph (04) 801 9005
Christchurch	•Ph (03) 379 1662
Freecall Orders	•Ph 0800 452 9227

Deluxe Solar Education Kit

NEW KIT

A series of experiments to acquire a basic knowledge of solar energy. Includes Solar cell, musical unit, plastic lamp, motor accessories and plastic adaptors.

Cat. KJ-6694 $24.95

50MHz Frequency Meter Kit

Ref: Silicon Chip October 2003.
Testing far beyond the reach of most multimeters and into the realm of an expensive Oscilloscope. It features autoranging, a large 8 digit LCD readout and is very accurate. Kit supplied with PCB, case, silk-screened laser cut front panel, LCD, pre-programmed PCB micro and all electronic components.

Cat. KC-5369 $69.95

'Smart' Slave Flash Trigger Kit for Cameras

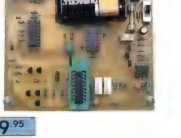
•Ref: Silicon Chip July 2003.
•Triggers external flash systems for more professional photography.
•Kit supplied with PCB, silk screened front panel and all electronic components

* Flash trigger lead not supplied.

Cat. KC-5364 $29.95

Serial PIC Programmer Kit

Ref: Silicon Chip September 2003.
This great little programmer can be battery powered! It features a portable, robust design and has provisions for In Circuit Serial Programming (ICSP) for micros which support this programming feature. This avoids the need to unplug a PIC from it's circuit to make and test changes to the code. It simply connects to your PC's serial port. Kit supplied with PCB and all electronic components. ZIF socket, serial cable and battery not supplied.



Cat. KC-5367 $39.95

Prices valid to 31st March '04

MAIL ORDERS - FREE POST TO:
Reply Paid 6424. Jaycar Techstore Mail Orders. PO Box 6424, Silverwater NSW 1811

Freecall For Orders 1800 022 888

Jaycar ELECTRONICS

www.jaycar.com.au

PRODUCT SHOWCASE

PC Fault Analysis Made Simple

Many faults in PCs are relatively easy to fix – if you know where the fault is. For those "in the know" (such as PC techs), diagnosing many faults has been relatively simple because the PC itself often tells you where the fault lies.

It does this during its own "Power on Self Test" (POST) phase. Technicians have used this information for years but the difficulty for the average user, until now, has been in interpreting what the computer is trying to tell you.

It has just become a whole lot easier with the SortTronx POST diagnostic card. This ISA and PCI card (both connectors are on the one card) includes an alphanumeric display, LED indicators and a speaker and, most importantly, has a complete listing of the BIOS codes used by various computer and BIOS manufacturers.

When an error is found during the POST, the card reports via a series of LEDs and hexadecimal codes – you simply look up the code to reveal your problem.

Problems with the motherboard itself, CPU, memory, display card, power supply and so on are revealed, even if there is no display on the monitor. In fact, it will work without a graphics card or memory – and tell you that they aren't present.

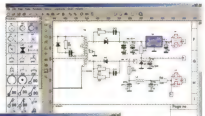
The POST diagnostic card sells for less than $100 including P&P and is available from **softronx@ bigpond.com**.

Wholesale enquiries are also welcome.

Contact:
Softronx
PO Box 477, Yarra Junction Vic 3797
Tel: 0419 354 302
email: softronx@bigbond.com

Budget schematic, PC board layout software

Abacom's new sPlan is an easy-to-use, budget-priced Windows CAD-software package for developing electronic and electric circuit diagrams It is ideal for the professional, student and amateur. It has drawing and editing functions that allow clear, professional circuit designs. sPlan produces high-quality printouts, which can be previewed to adjust scale and position of the print.



You can use the existing component library or you can draw and add your own symbols. Symbols are "dragged and dropped" from the library to the diagram and they fit exactly to the grid.

Similarly, Sprint-Layout is an easy-to-use, budget priced Windows CAD-software package for creating layouts for single-sided and double-sided PCboards). It is equipped with tools to draw pads, tracks, copper areas, labels and so on. All parameters such as track width, pad size, etc are always visible at a glance, and can be edited any time.

You can edit existing layout-elements very easily. Adjusting the width of a track will show immediately on the layout. Functions such as copy, move, rotate, mirror, etc are also available.

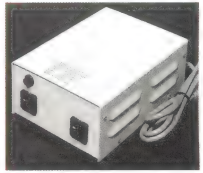
Components which you have drawn can be added to those in the existing, extensive component library. You can easily drag and drop the components from the library to your layout. After that, you can mirror, rotate or label them as you wish.

When the design is complete, you can produce the necessary Gerber-files for manufacture. Other users can take a look at your layouts and print them, with the free viewer software.

Both packages are priced at just $65. More information and a demo version of sPlan is available from Ocean Controls at their website.

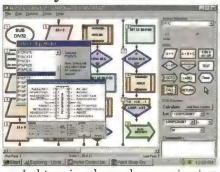
Contact:
Ocean Controls
4 Ferguson Dr, Balnarring, Vic,3926
Tel: (03) 5983 1163 Fax: (03) 5983 1120
Website: oceancontrols.com.au

STEPDOWN TRANSFORMERS
60VA to 3KVA encased toroids



Harbuch Electronics Pty Ltd
9/40 Leighton Pl. HORNSBY 2077
Ph (02) 9476-5854 Fx (02) 9476-3231

PIC16Cxxx family library for CoreChart



eLabtronics have been winning awards and acclaim for their innovative CoreChart Graphical Assembler software since its release at the World ICT Conference in 2002.

Now the South Australian company has released a Microchip PIC16Cxxx Family Library CD for CoreChart.

Included on the new Library CD are additional projects, more advanced subroutine modules, direct support for an expanded set of chip configurations, as well as valuable technical data – useful for professionals and enthusiasts who want to save even more time by using pre-packed CoreChart subroutines for PIC16Cxxx family chips. The new library now supports 82 chips, with the ability to import subroutines to any chip and export new subroutines to expand the library. The Microchip Technical Manual for the chip you are working on can be accessed with a single click.

The powerful new subroutine modules allow the user to more easily develop programs for new, exciting applications such as A-to-D, EEPROM Access, Frequency-Tacho Readings, I2C-24LC256 Memory Access, Interrupts, Keypad, LCD, PWM, RS232 and Arithmetic Modules.

Example projects on the CD include LDR Levels, Stepper Motor Control, Water Level Sensors, Greenhouse Temperature Control and Interrupt based Real Time Clocks.

More information is available at **www.elabtronics.com/products_cat_CoreChart.htm**. A CoreChart Software Licence is AU$132, the CoreChart PIC16Cxxx Library is AU$275, but a package of both is AU$330 inc GST.

Contact:
eLabtronics
51 Byron Place, Adelaide, SA 5000
Tel: (08) 8231 5966 Fax: (08) 8231 5266
Website: www.elabtronics.com

Real-Time Spectrum Analysis

Tektronix new series of real-time spectrum analysers provide the first complete measurement package for engineers developing cutting-edge RF techniques, ranging from RF Identification (ID) tags to radar applications. They provide the unique ability to trigger, capture and analyse time-varying RF signals.

Today's RF signals carry complex modulation and change from one instant to the next, hopping frequencies, spiking briefly and then disappearing. As a result, these RF signals are difficult to measure and present unpredictable behavior, making engineers' ability to observe RF devices with existing spectrum analyzers extremely challenging.

Tektronix' new portfolio of real-time spectrum analyzers, include the RSA2200A Series and the RSA3300A Series. Designers and researchers working on advanced RF applications need efficient tools that can trigger, capture and analyze the spectral behavior of rapidly changing signals over relatively long time periods.

This record of real-time signal behavior supports powerful analysis tools such as the spectrogram display, which plots frequency and power amplitude changes over time—many minutes of time in some cases.

The frequency, time and modulation domains are all visible in time-correlated displays, while the spectrogram itself summarises the long-term view, enabling an intuitive, three-dimensional look at the time-varying signal behavior, otherwise unseen in traditional frequency domain displays.

The new series comprise four models in total: RSA2203A, RSA2208A, RSA3303A, and RSA3308A.

These encompass frequency ranges up to 8 GHz with various memory depth configurations. Real-time spectrum analysis is standard on all models.

Contact:
NewTek Sales
11 Lyon Park Rd, North Ryde, NSW 2113
Tel: (02) 9888 0100 Fax: (02) 9888 0125
Website: www.newteksales.com

NI reduces data acquisition prices up to 25%

National Instruments has announced a price reduction of up to 25% for 13 of its most popular data acquisition modules.

The price reduction applies to all regions of the world for NI data acquisition devices ranging from 200,000 S/s to 1.25 million S/s, 12 to 16-bit resolution and 16 to 64 analog inputs.

NI data acquisition cost per I/O channel has decreased by 74% since 1990. Most recently, NI has taken advantage of low-cost, off-the-shelf technologies and significant increases in manufacturing efficiency to pass additional savings on to customers.

For example, a customer who purchases the 16-bit, 64 analog input PCI-6031E device benefits from a savings of AU$530 – an-up-to-25% price reduction.

In addition to taking advantage of these significantly lower data acquisition prices, engineers and scientists can reduce their total cost of measurement through innovative NI software technologies.

For example, the new NI-DAQmx measurement services software lowers application development costs by substantially reducing the time-costs of software development, system set-up, configuration, maintenance and calibration.

For more information on this worldwide price reduction as well as a listing of all DAQ modules involved, readers may visit **www.ni.com/dataacquisition**.

Contact:
National Instruments
Tel: 02 9889 1033 Fax: 02 8572 5290
Website: www.ni.com

SILICON CHIP WebLINK

How many times have you wanted to access a company's website but cannot remember their site name?

Here's an exciting new concept from SILICON CHIP: you can access any of these organisations instantly by going to the SILICON CHIP website (www.siliconchip.com.au), clicking on WebLINK and then on the website graphic of the company you're looking for. It's that simple. No longer do you have to wade through search engines or look through pages of indexes – just point'n'click and the site you want will open!

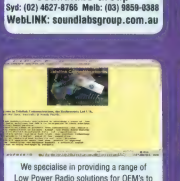
Your company or business can be a part of SILICON CHIP's **WebLINK**. For one low rate you receive a printed entry each month on the SILICON CHIP **WebLINK** page with your home page graphic, company name, phone, fax and site details plus up to 50 words of description – and this is repeated on the **WebLINK** page on the SILICON CHIP website – with the link of your choice active. Get those extra hits on your site from the right people in the electronics industry – the people who make decisions to buy your products. Call SILICON CHIP today on (02) 9979 5644

BitScope is an Open Design Digital Oscilloscope and Logic Analyser. PC software drives BitScope via USB, Ethernet or RS232 to create a powerful Virtual Instrument. BitScope is available built and tested or in kit form. Extensive technical details are available on the website. Great for hobbyists, university labs and industry.

BitScope Designs

Contact: sales@bitscope.com

WebLINK: bitscope.com



- HiFi upgrades & modification products - jitter reduction and output stage improvement.
- Danish high-end hifi kits - including pre-amps, phono, power amps & accessories.
- Speaker drivers including Danish Flex Units plus a range of accessories.

Soundlabs Group

Syd: (02) 4627-8765 Melb: (03) 9859-0388

WebLINK: soundlabsgroup.com.au

A 100% Australian owned company supplying frequency control products to the highest international standards: filters, DIL's, voltage, temperature compensated and oven controlled oscillators, monolithic and discrete filters and ceramic filters and resonators.

Hy-Q International Pty Ltd

Tel:(03) 9562-8222 Fax: (03) 9562 9009

WebLINK: www.hy-q.com.au

Our website is updated daily, with over 5,500 products available through our secure online ordering facility.

Features include semiconductor data sheets, media releases, software downloads, and much more.

JAYCAR ELECTRONICS

Tel: 1800 022 888

WebLINK: www.jaycar.com.au

At **QUESTRONIX** we specialise in conversion, switching and distribution equipment for VGA, video and audio. We have been serving the audiovisual industry as well as pro, semi-pro and domestic a-v equipment users since 1988. As well as being a 100% Australian manufacturer we also import a range of innovative and interesting items.

QUESTRONIX

Tel: (02) 4343 1070 Fax: (02) 4341 2795

WebLINK: www.questronix.com.au

We specialise in providing a range of Low Power Radio solutions for OEM's to incorporate in their wireless technology based products. The innovative range includes products from **Radiometrix**, the World's leading manufacturer.

TeleLink Communications

Tel:(07) 4934 0413 Fax: (07) 4934 0311

WebLINK: telelink.com.au

JED designs and manufactures a range of single board computers (based on Wilke Tiger and Atmel AVR), as well as LCD displays and analog and digital I/O for PCs and controllers. JED also makes a PC PROM programmer and RS232/RS485 converters.

Jed Microprocessors Pty Ltd

Tel: (03) 9762 3588 Fax: (03) 9762 5499

WebLINK: jedmicro.com.au

International satellite TV reception in your home is now affordable. Send for your free info pack containing equipment catalog, satellite lists, etc or call for appointment to view. We can display all satellites from 76.5° to 180°.

Av-COMM Pty Ltd

Tel:(02) 9939 4377 Fax: (02) 9939 4376

WebLINK: avcomm.com.au

Farnell Health & Safety Catalog

Farnell InOne have just released their new Health & Safety Catalog.

Safety, security and protection of your employees in the workplace becomes more and more vital in an environment where safety standards continue to become more stringent.

The new Health & Safety Catalog introduces a bigger range of personal protection, hygiene and site and safety products that meet Australian and New Zealand standards, with brands such as 3M, MSA, Hard Yakka, Roebuck, Brady, Bata and Karcher.

The Health & Safety Catalog features comprehensive indexes, enabling you to search by Farnell InOne order code, manufacturers' part number or you can browse by product category. You'll find what you want – quickly.

When it comes to finding the right product for your needs the catalog has in-depth product descriptions and technical information to help you make the right decisions. It also includes quantity break pricing.

To request your FREE copy of the Farnell InOne Health & Safety Catalog call either of the numbers below for Australia or NZ.

Contact:
Farnell InOne
PMB 6, Chester Hill NSW 2162
Tel: 1300 361 005 (NZ 0800 90 80 80)
Website: www.farnellinone.com

The easy way to identify faulty electros

ESR Meter Mk.2

Pt.1: By BOB PARKER

Forget about capacitance meters – an ESR meter is the way to go when it comes to identifying faulty electrolytics. This well-proven design is autoranging, low in cost and simple to build.

ESR Meter: Main Features

- In-circuit testing, made possible by using <100mV test voltage which won't forward bias diodes or transistors.
- Auto-ranging to cover 0.01-99Ω.
- Non-polarized test leads due to no DC component in the test signal.
- Single pushbutton to easily control all functions.
- Test lead resistance zeroing.
- Automatic switch-off after three minutes when the meter is idle.
- Low battery voltage warning – "b" blinks on the display.
- 13mm LED displays for easy viewing from a distance.
- Chart of typical electrolytic capacitor ESR figures on the front panel.

IT'S HARD TO BELIEVE that it's already eight years since my first ESR (equivalent series resistance) meter was described – in the January 1996 edition of "Electronics Australia". It was designed on a 386 PC!

The ESR meter allowed service technicians to quickly and easily identify defective electrolytic capacitors while they were still in circuit. It measures a characteristic of electrolytic capacitors which is very important: the "equivalent series resistance" or ESR.

Back then, no-one (including myself) expected that a meter designed to measure a capacitor characteristic hardly anyone had ever heard of would become popular in Australia, let alone overseas. However, we didn't consider the explosive growth of the Internet. Thanks to people discussing it on various newsgroups and by email, about 12,000 ESR meter kits have now been sold and sales (mainly outside Australia) continue to be strong.

Over those eight years, both Dick Smith Electronics (which sells the kit) and the author have received many suggestions from constructors on improving the ESR meter kit – particularly on making the construction easier. This upgraded version is the result and incorporates many of those ideas. As before, it will be available as a complete kit from DSE.

What's ESR?

Before taking a look at what's changed in this "Mk2" version of the ESR meter, let's take a look at what an ESR meter does. First, we need to get into a bit of boring theory to understand how electrolytic capacitors (which I'll refer to simply as "electrolytics" from here on) are constructed and work. This is necessary to understand why they cause so many electronic faults.

Fig.1 is a simplified cross-section drawing which shows the basics. As with many other kinds of capacitors, the plates of an electrolytic consist of two long aluminium foil strips wound into a cylinder. The big difference is that the dielectric isn't a strip of plastic or other insulating material separating these plates, but an extremely thin layer of aluminium oxide which is formed directly onto the anode foil itself during the manufacturing process.

As part of an electrolytic's electrochemical operation and to achieve the closest possible electrical contact with the cathode side of the oxide layer, a separating strip of porous material (generally paper) is sandwiched between the plates. This separator is soaked with a highly conductive liquid called the "electrolyte", which effectively connects the negative plate to the oxide layer and gives the capacitor its name. In very old electrolytics, the electrolyte was water-based but they now use water-free formulas.

Because electrolytics make use of a conductive liquid to complete the electrical circuit between the cathode plate and one side of the dielectric, the electrolyte's electrical resistance is critical. It is the major component of the capacitor's "equivalent series resistance" or "ESR". Other components of ESR are the inductance of the wound capacitor element, the resistances of the internal connections and the impedance of the capacitance itself.

In operation, electrolytic capacitors can function perfectly for decades.

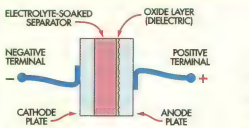


Fig.1: simplified cross-section of an electrolytic capacitor. The dielectric consists of a thin layer of aluminium oxide on the anode plate and this is connected to the cathode plate via an electrolyte-soaked separator.

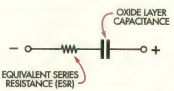


Fig.2: as shown in this diagram, the electrical resistance of the electrolyte is in series with the capacitance of the oxide dielectric. It is the major component of the "equivalent series resistance" or "ESR" of an electrolytic capacitor.

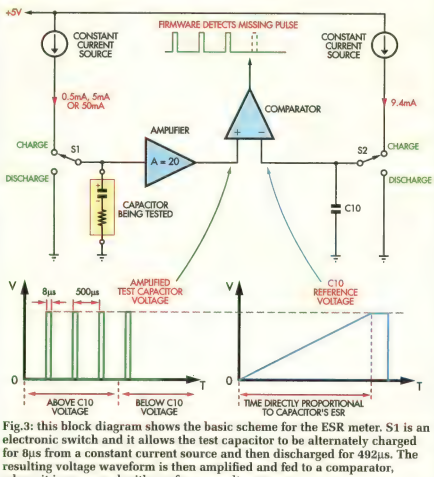


Fig.3: this block diagram shows the basic scheme for the ESR meter. S1 is an electronic switch and it allows the test capacitor to be alternately charged for 8µs from a constant current source and then discharged for 492µs. The resulting voltage waveform is then amplified and fed to a comparator, where it is compared with a reference voltage ramp.

However, there are some conditions which will cause the electrolyte's resistance (ESR) to increase. This can eventually reach a point where it causes problems for the circuit.

Normally, a flexible rubber seal keeps the electrolyte contained inside the aluminium case of the capacitor. If the seal fails (as it regularly does in surface-mount electrolytics), the electrolyte will leak and/or dry out.

The two other big killers are: (1) high temperatures where the electrolytic is located; and (2) high levels of ripple current through the capacitor, which cause elevated temperatures inside it. These conditions cause chemical changes to the electrolyte, increasing its resistance.

This is why time after time, repair technicians find electrolytics failing in switchmode power supplies, the deflection stages of CRT TVs and monitors, and other power circuitry

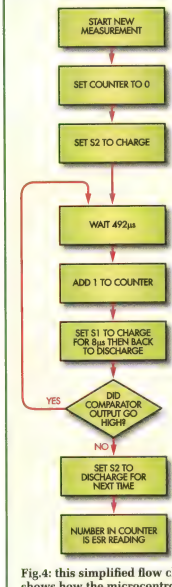


Fig.4: this simplified flow chart shows how the microcontroller takes an ESR measurement. It simply counts the measurement pulses until the comparator output no longer goes high during one of them.

such as electronically-commutated motors where both of those conditions are common.

Why high ESR causes trouble

The function of an electrolytic capacitor is to block DC while acting as a low impedance to any AC voltage across it. As a power supply filter, an electrolytic smooths rectified voltage and so has to pass the AC ripple voltage on it. This causes "ripple" current through the capacitor.

In a perfect capacitor, such ripple current causes no internal heating or other problems but real world capacitors have ESR. The ripple voltage across this "equivalent series resistance" causes circuit losses as well as heating within the capacitor, if it becomes excessive.

For example, in switchmode power supplies, high ESR can cause starting failure, loss of regulation and excessive high-frequency noise on the outputs. Similarly, deflection circuits can suffer from distorted and reduced scanning waveforms. In fact, high electrolytic capacitor ESR often causes strange problems which are hard to make sense of.

It's worth noting that ESR increases rapidly as the temperature drops. As a result, defective electrolytics are often indicated by faults which are worst in winter and when the equipment is first switched on, with the symptoms gradually diminishing as the temperature rises.

Capacitance vs ESR meters

In the past, technicians didn't have much choice but to check suspect electrolytics using a capacitance meter. Unfortunately, capacitance meters are generally useless for weeding out electrolytics which are causing trouble. They're generally designed to ignore the ESR and show only the actual capacitance which usually stays close to its correct value, even when the ESR has gone through the roof! In addition, the capacitor must be disconnected from the circuit before making capacitance measurements.

Now you can see why ESR meters have become so popular with technicians. They're designed to directly measure the very characteristic which is causing the fault.

What's more, this measurement can be made with the capacitor still in circuit (while the equipment is safely disconnected from power). This avoids the inconvenience of having to unsolder it, which incidentally also heats it up and makes the ESR drop, thereby masking the problem.

Microcontroller-based meter

Unlike most other ESR meters, this design is based on a microcontroller IC. This custom-programmed chip makes possible the extensive range of features offered (see panel). It also greatly contributes to the small size, low cost and simplicity of the ESR meter.

The microcontroller drives two 7-segment LED displays to give a direct readout of ESR measurement.

How it works

An ESR meter's job is to measure the resistance of an electrolytic capacitor's electrolyte while (as far as possible) ignoring the capacitive reactance. Fig.3 shows a simplified diagram of how this is done in the ESR meter described here.

As shown, switch "S1" (in reality, an electronic switch driven by the microcontroller) alternately connects and disconnects the capacitor being tested to a constant current source of either 0.5mA, 5mA or 50mA (depending on the range). In practice, the capacitor is alternately charged for 8µs (S1 in the "Charge" position) and discharged for 492µs (S1 in the Discharge" position).

Because the test current pulses are so short, the voltage pulses developed across the capacitor are essentially proportional to its ESR. That's because capacitors with values above about 1µF don't have time to charge enough to significantly affect the reading.

The voltage pulses across the capacitor are fed to a non-inverting wideband amplifier with a gain of 20. The resulting signal is then applied to the non-inverting input of an op amp comparator (inside the microcontroller) and compared against a reference voltage which increases linearly with time.

Analog-to-digital conversion

In operation, the test current pulses are applied to the capacitor at a constant rate of one every 500µs (ie, 8µs charge, 492µs discharge). At the same time, capacitor C10 is charged via another constant current source, so that its voltage increases linearly at a rate of 10mV/500µs. The resulting linearly increasing voltage on C10 is applied to the inverting input of the comparator.

As a result, the comparator's output will go high during each ESR measurement pulse, until C10's voltage exceeds the pulse amplitude. When that happens, the comparator's output stays low and the missing output pulses are detected by the firmware in the microcontroller.

Fairly obviously, the number of pulses that occur up until this point is directly proportional to the capacitor's ESR. It's simply a matter of using the

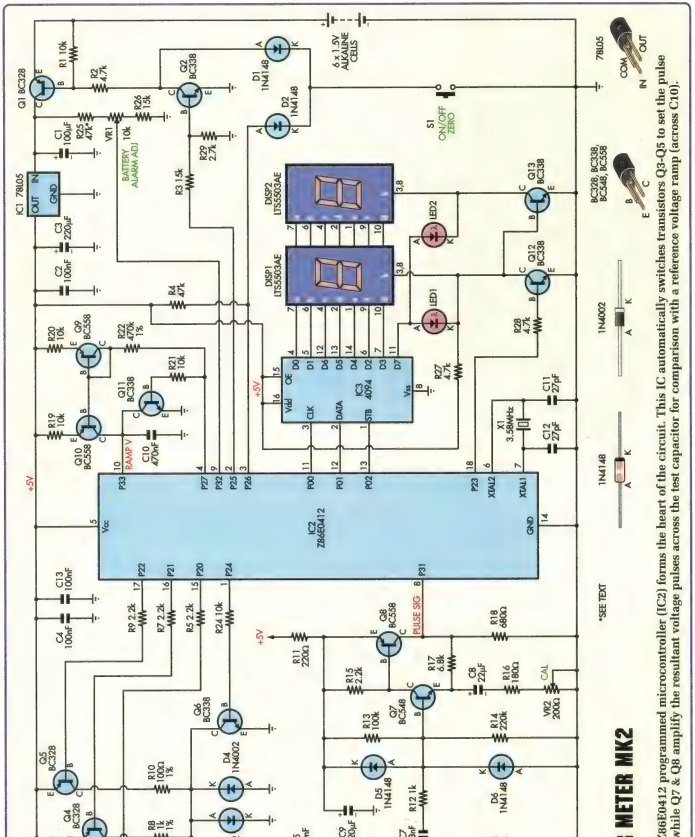
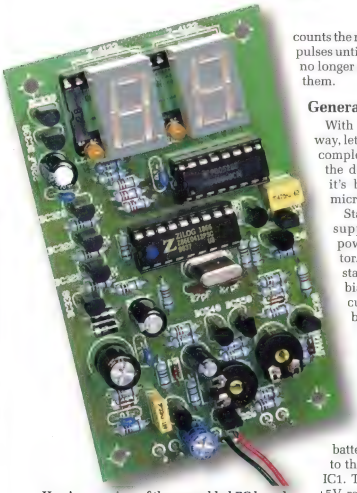


Fig.5: a Zilog Z86E04012 programmed microcontroller (IC2) forms the heart of the circuit. This IC automatically switches transistors Q3–Q5 to set the pulse current level, while Q7 & Q8 amplify the resultant voltage pulses across the test capacitor for comparison with a reference voltage ramp (across C10).



Here's a preview of the assembled PC board. The construction details are in Pt.2.

microcontroller to count these pulses to obtain a reading on the display (and microcontrollers are very good at counting).

Fig.4 shows the simplified flow chart of how the microcontroller takes an ESR measurement. It simply counts the number of measurement pulses until the comparator output no longer goes high during one of them.

General operation

With the basics out of the way, let's now take a look at the complete circuit. Fig.5 shows the details. As can be seen, it's based on a Z86E0412 microcontroller (IC2).

Starting with the power supply, Q1 is the main power switching transistor. In the meter's "off" state, Q1 has no forward bias and so no significant current flows from the battery.

Conversely, when switch S1 is pushed, base current flows from Q1 and through resistor R2 and diode D1 to ground. Q1 thus switches on and effectively connects the battery's positive terminal to the input of 5V regulator IC1. This in turn provides a +5V rail to power microcontroller IC2 and the rest of the circuit.

As soon as power is applied, IC2's crystal oscillator (based on 3.58MHz crystal X1) starts and IC2 begins executing the instructions in its firmware. The first "external" thing it does is drive pin 2 to +5V and this turns on transistor Q2 via resistor R3 (15kΩ). As a result, Q2 takes over from pushbutton switch S1 in maintaining Q1's base current through R2, thus ensuring that the power remains on when S1 is released.

Pulsed current sources

Transistors Q3, Q4 and Q5 are driven by pins 15-17 of IC2 (via 2.2kΩ resistors) and function as switches. Depending on the range chosen, the Z86 pulses one of these transistors on for 8µs every 500µs, to apply short current pulses via C5 & C6 to the capacitor being tested.

Resistors R6, R8 & R10 set the pulse current to either 0.5mA, 5.0mA or 50mA, while capacitors C5 and C6 block any DC component from reaching the test leads. Note that bipolar electrolytic capacitor C6 is in series with the current source resistors, so its own ESR is effectively "swamped" by the relatively high resistor values. C5 is included to preserve the high-frequency response of the pulse waveform and to further reduce the effect of C6's ESR.

Between the 8µs pulses, IC2 drives its pin 1 port to +5V. This turns Q6 on and discharges the series combination of C5/C6 and the capacitor under test.

Pulse amplifier

The current pulses developed across the test capacitor are fed via C7 and R12 to a fast non-inverting pulse amplifier based on transistors Q7 and Q8.

These two transistors are wired as common-emitter stages, with feedback applied via R17 to give an overall gain of about 20, depending on the setting of VR2. The amplified signal output from this stage is then fed to the non-inverting input of one of IC2's comparators via pin 8, so that it can be compared with the reference voltage.

Reference voltage generator

Transistors Q9 and Q10 form a current mirror circuit which works with capacitor C10 to provide the reference voltage (see Fig.3). It works like this: when Q9 is on (ie, when pin 4 of IC2 is low), approximately 9.4µA flows through this transistor and R22. This current is "mirrored" by Q10, so the same amount of current also charges C10 (470nF) at a linear rate towards the +5V supply for as long as pin 4 of IC2 is held low.

What's Changed In The Mk.2 Version

- Front panel chart figures updated to reflect current-generation electrolytic capacitors.
- PC board now has silk-screened component overlay, solder masking and holes under the trimpots for adjustment after final assembly.
- Improved appearance, with countersunk screws, etc.
- Automatic switch-off time increased from two minutes to three minutes.
- Holder for 6 AAA cells instead of a 9V alkaline battery for longer times between battery replacements (and to finally end constructor confusion about how to keep the battery in place).
- Smaller more reliable pushbutton switch which is harder to accidentally bump in a toolbox.
- Automatic self-testing of the meter's circuitry added to the microcontroller firmware, to simplify fault-finding if a newly-built meter doesn't work properly.

The ramp voltage developed across C10 is applied to pin 10 of IC2. This pin is the common inverting input of the two voltage comparators inside the Z86. Q11 discharges C10 when IC2 switches its pin 4 port to +5V at the end of each measurement cycle.

Range changing

While ever the power is switched on, the Z86 goes through a regular measurement routine in which it starts C10's voltage ramping up and then drives either Q3, Q4 or Q5 with 8µs pulses that are 500µs apart. This produces measurement ranges of 0.00-0.99Ω, 1.0-9.9Ω and 10-99Ω.

If a reading is offscale, the unit automatically drops to the next lowest test pulse current and checks again. However, if it's already on the 10-99Ω range and the reading is offscale, it will display "-" to indicate a reading above 99Ω.

Conversely, if it gets a very low reading, it will keep going to the next highest test current, until it's found the highest on-scale reading. The reading is then shown on the 7-segment LED displays.

Driving the displays

To display the reading, the Z86 microcontroller sends out eight bits of data (in sequence) every 5ms to IC3, a 4094 serial-to-parallel shift register. These data bits correspond to the LED display segments and to the decimal points which are formed using LEDs 1 & 2.

In operation, the LED displays (DISP1, DISP2 and LEDs 1 & 2) are switched at a 100Hz rate by transistors Q12 and Q13. Q12 is driven (via R28) from the P23 output (pin 18) of IC2, while Q13 is biased on via R27, which connects directly to the +5V rail. Q13 toggles off when Q12 turns on and turns back on again when Q12 turns off.

Due to the slow response of the human eye, the displays all appear to be constantly illuminated. This technique is called "multiplexing" and it allows the two displays to share a common drive circuit.

Test lead resistance zeroing

The resistance of the test leads can be compensated for by again pressing switch S1 (ie, after the unit has been

What Are Typical ESR Readings?

So what are typical ESR readings for various electrolytic capacitors? Unlike other electrical characteristics, there's no such thing as a "normal" ESR value for an electrolytic of a given capacitance and operating voltage. The ESR to a large extent depends on the physical size of the capacitor and whether it's a low-ESR or high temperature-rated type. It also varies between manufacturers. In addition, ESR increases rapidly as the temperature drops and vice versa.

The chart on the front of the meter contains sample ESR values for a range of common electrolytic capacitor values and voltage ratings. These have been derived both from physical measurements on a range of capacitors and from manufacturer's data sheets. It's only intended as a rough guide, to give an idea of what to expect until you become familiar with using the ESR meter.

SILICON CHIP

Car Projects, Volume 2

THE PROJECTS: High-Energy Universal Ignition System; High-Energy Multispark CDI System; Programmable Ignition Timing Module; Digital Speed Alarm & Speedometer; Digital Tachometer With LED Display; Digital Voltmeter (12V or 24V); Blocked Filter Alarm; Simple Mixture Display For Fuel-Injected Cars; Motorbike Alarm; Headlight Reminder; Engine Immobiliser Mk.2; Engine Rev Limiter; 4-Channel UHF Remote Control; LED Lighting For Cars; The Booze Buster Breath Tester; Little Dynamite Subwoofer; Neon Tube Modulator.

Available from SILICON CHIP

Mail order prices:
Aust: $14.95 (incl. GST & P&P)
NZ/Asia Pacific: $18.00 via airmail
Rest of World: $21.50 via airmail

Order by phoning (02) 9979 5644 & quoting your credit card number; or fax the details to (02) 9979 6503; or mail your order with cheque or credit card details to Silicon Chip Publications, PO Box 139, Collaroy, NSW 2097.

Parts List

1 PC board, code ZA1044, 95 x 57mm
1 3.58MHz crystal, HC-49/U case (X1)
1 16-pin IC socket
1 18-pin IC socket
1 28-pin IC socket
6 AAA alkaline cells
1 6 x AAA cell holder
1 plastic utility box, type UB3
1 miniature momentary-contact pushbutton switch
2 4mm banana sockets
1 pre-punched silk-screened front panel
1 red perspex display filter
4 15mm spacers
6 PC pins
8 washers
1 set of test leads
1 10kΩ PC-mount trimpot (VR1)
1 200Ω PC-mount trimpot (VR2)

Semiconductors

4 1N4148 or 1N914 signal diodes (D1,D2,D5,D6)
2 1N4004 power diodes (D3,D4)
4 BC328 PNP transistors (Q1, Q3,Q4,Q5)
5 BC338 NPN transistors (Q2, Q6,Q11,Q12,Q13)
1 BC548 NPN transistor (Q7)
3 BC558 PNP transistors (Q8, Q9,Q10)
1 78L05 3-terminal regulator (IC1)
1 Z86E0412 programmed microcontroller (IC2)
1 4094 CMOS shift register (IC3)
2 LSD5114 or LTS5503AE 7-segment LED displays (DISP1, DISP2)
2 3mm red LEDs (LED1,LED2)

Capacitors

2 220µF 16V RB electrolytic (C3,C9)
1 100µF 16V RB electrolytic (C1)
1 47µF 50V bipolar RB electrolytic (C6)
1 22µF 16V RB electrolytic (C8)
1 470nF 63V MKT (C10)
4 100nF 50V disc or monolithic (C2,C4,C5,C13)
1 33nF 63V MKT (C7)
2 27pF 50V NPO disc ceramic (C11,C12)

Resistors (0.25W, 1%)

1 470kΩ	4 2.2kΩ
1 220kΩ	2 1kΩ
1 100kΩ	1 680Ω
2 47kΩ	1 220Ω
2 15kΩ	1 180Ω
7 10kΩ	1 100Ω
1 6.8kΩ	1 68Ω (for calibration)
3 4.7kΩ	1 5.6Ω (for calibration)
1 2.7kΩ	

Miscellaneous

Hookup wire & solder

powered up) while the test lead probes are held tightly together (to minimise contact resistance). When this is done, pin 3 of IC2 is pulled low via D2 and S1 and the microcontroller goes into its test lead zeroing routine.

If the reading is less than 1Ω (as all test leads are), it saves this value for as long as the meter is switched on. It then subtracts it from all subsequent readings, so that only the ESR of the capacitor being tested is displayed (ie, so that the reading is unaffected by the test lead resistance).

Switching off

Pressing S1 while the test leads are separated (or connected to a resistance of 1Ω or higher) initiates the "switch-off" routine (assuming, of course, that the unit is already on).

What happens is that the Z86 stops making measurements and switches its pin 2 port to 0V, in turn switching off transistor Q2. Then, when you release S1, Q1 switches off and the meter shuts down.

In addition, the ESR Meter includes an automatic power-off function. This shuts the meter down if it has been idle for more than three minutes.

It works like this: as long as the meter is actively taking readings, it keeps resetting a 3-minute timer function in the Z86 microcontroller. However, if the unit is left idle (even with the test leads touching), the Z86 automatically switches its pin 2 port low after three minutes, thus turning off the power.

This automatic switch-off function may be a nuisance in some situations, however. Hence, it can be easily disabled if necessary (see the "Optional Modifications" panel in Pt.2).

Battery voltage warning

A simple voltage divider consisting of trimpot VR1 and series resistors R25 & R26 makes up the battery warning circuit. This divider is connected across the switched battery voltage and VR1 is adjusted so that it applies 2V to pin 9 of IC2 when the battery voltage is at 7V (ie, the minimum at which the regulator will continue to regulate).

Pin 9 is the non-inverting input of IC2's second internal comparator. In operation, IC2 switches its pin 4 port to 0V for a period of 100ms several times per second, to allow C10 to charge up to a predictable 2V. The second comparator inside IC2 then compares this 2V reference against the voltage on VR1's wiper.

If the battery voltage is down to 7V, IC2 reduces the time each LED display is switched on by 50%. This reduces the load, which allows the battery voltage to slightly rise again and provide a bit more operating time. It also flashes a "b" on the righthand digit at a 1Hz rate until the power is turned off.

Protection circuitry

Last but not least, the meter needs to be protected against being connected to charged capacitors. This protection is partially provided by back-to-back diodes D3 and D4. If an external DC voltage (ie, a charged capacitor) is connected, one of these diodes conducts and forces non-polarised capacitors C5 and C6 to charge up to that voltage.

Additional protection is provided by C7, R12, D5 & D6 which stop excessive input voltages from damaging transistors Q7 and Q8 in the pulse amplifier circuit. In particular, diodes D5 & D6 acts as voltage clamps – D5 ensures that the voltage on Q7's base cannot go above 5.6V, while D6 ensures that this voltage cannot go below -0.6V.

Finally, extra "heavy-duty" protection can be added by connecting a pair of back-to-back high-power diodes (not shown on the circuit) between the test terminals. The "Optional Modifications" panel in Pt.2 next month has the details.

Next month, we'll show you how to build the ESR Meter and describe how it is used. There's also a full trouble-shooting and diagnostics procedure in case you encounter difficulties. SC

ELECTRIC SCOOTERS

NEW PRODUCTS!!

Electric bikes /scooters

Unlike a lot of others these have Australian electrical and approvals including **C TICK.**
(SC1)

This compact light weight scooters fold up for easy carrying and storage. Features inc variable speed control, adjustable / removable seat, hand lever style brake. Brake and throttle can be swapped from side to side. Telescopic handlebars to suit most riders. Comes complete with mains charger and batteries.

Motor:	100W
Battery:	24V 4AH
Speed:	12KM/H
Range:	14-16km
N.W:	8KGS
G.W:	10KGS
Meas:	740 X 130 (deck) X 930mm

NOTE: These scooters are not toys and should only be used under adult supervision and only where approved by local authorities.

ELECTRIC BIKE

Checkout this full featured bike including variable speed, adjustable handlebars and seat, lights, front and rear suspension, inflatable wheels, side stand & more. (SC2)

Motor:	200W
Battery:	12V 12AH
Speed:	18KM/H
Range:	Greater than 20km
G.W:	27KGS

NOTE: These scooters are not toys and should only be used under adult supervision and only where approved by local authorities.

*** MAGNETS ***

VERY STRONG NEODYMIUM IRON BORON
RARE EARTH MAGNETS. Zinc coated.

G58	**3mm round x 1.5mm thick**	**$0.20**
G32	**3mm round x 2mm thick**	**$0.25**
G72	**7mm round x 2.5mm thick**	**$0.45**
G37	**7mm round x 3mm thick**	**$0.55**
G103	**10mm round x 3mm thick**	**$0.70**
G105	**10mm round x 5 mm thick**	**$1.20**
G201	**15mm round X 20mm long**	**$5.50**

BP212SR BP SOLAR PANELS.

These are brand new self regulating 12W monocrystalline BP model BP212SR solar panels. You will find more information and a test report by searching for the part number BP212SR on the internet. Dimensions are 231mm * 561mm * 38.5 mm. & weighing 2.2Kg. Brand new in original packaging, worth around $300 Ea.. We have a good Quantity available. @ $120

Buy a number of solar panels, LED lamp kits & SLA battery/s & save 10%

(NEW) DAZZLE DIGITAL MEDIA USB READER

The Ultimate Digital Media Reader for users of digital cameras, MP3 players, mobile phones, PDAs & other portable devices which use Smart Media, SecureDigital (SD), MultimediaCard (MMC) & Compact Flash (CF). Dazzle Readers offer a fast & convenient method to transfer pictures, music & data to your PC. Only $6.90

More info on our web site.

$$$ MORE LUX $$$
$$$ FOR YOUR BUX $$$

We believe that our 5mm ULTRABRIGHT WATERCLEAR LED'S give you the MOST LUX FOR YOUR BUCKS, this applies even when their multiple arrays are compared to the high Lux LED's! CHECK OUT OUR NEW YEAR PRICES:

5mm RED ULTRABRIGHT.....40C
5mm GREEN... ULTRABRIGHT.....50C
5mm BLUE... ULTRABRIGHT.....50C
5mm WHITE... ULTRABRIGHT.....70C

THE FOLLOWING HAVE A BUILT IN IC THAT PRODUCES A COLOUR SEQUENCED LIGHT SHOW:

5mm RED-GREEN.....70C
5mm RED-BLUE.....70C

SLA BATTERY CHARGER

This switched mode inverter is designed to charge Sealed Lead Acid batteries & any other 12V lead acid batteries to their end point of 13.8V when being charged from 12V car or boat batteries: An "up" voltage inverter that can be used in many other applications.
Our new circuit was slightly modified to improve the efficiency and make provision to increase the charging current. Easily modified for greater currents. PCB and all on-board components.

LED COLLIMATING LENSES.

This 35mm diameter plastic lens was designed to collimate LED's, use it to converge a beam into a narrower spot and thus increase the CD rating and improve the beam quality:
60cEa. or 10 for $4.

CLOCK MOVEMENTS

Crystal controlled clock mechanisms with large hands. Requires 1X AA (not supplied.) Make your clock from a picture, piece of driftwood or your favourite family photo etc. $6 Ea. or 4 for $20. Hour hand: 68.5mm Minute hand: 92.5mm Second hand: 91mm

HOT NEW PELTIER PRICES

40 X 40 mm .

(GP1) 4.0A $12.50
(GP2) 6.0A $15.50
(GP3) 8.0A $18.50

For more info check our Website.

****NEW KIT** K140A PELTIER CONTROLLER**

Our old peltier (heater / cooler) controller kit (K140) has been revamped. Now smaller than ever. Kit includes PCB & all onboard components.$16.50

K203 BUDGET 4/2CH UHF SECURE MICROPROCESSOR BASED REMOTE CONTROL

The transmitter kit uses a pre-built 4 button 433MHz key-fob transmitter (requires minor assembly) with a mini telescopic antenna (range tested at over 200M, maybe higher). The receiver kit uses a pre-built and pre-tuned UHF module and 2 pre-programmed microprocessors. Features include onboard high current relays with indicator LEDs and screw terminals for easy connection. Any or all of the outputs can be set to momentary or latching action on any of the four channels from the transmitter. K203 Receiver kit inc. PCB, UHF module and all onboard components to build a 2ch receiver .$28
Extra components to add 2 channels K205A. $10
Transmitter kits TX7 .$12

Our K180 high security rolling code 4 ch UHF remote control is still available @ $54 for the RX & $25 for the TX.

4 CHANNEL 433Mhz UHF MODULES AND KEY-FOB TRANSMITTER

As used in our K203 Long range 4 channel transmitter with telescopic antenna, transmit LED and keypad cover to stop accidental button presses. TX7 $12. 4 channel UHF module. Pre-tuned to 433Mhz. No tuning required. RX7 $12

MULTIPURPOSE HEATER/ COOLER ASSEMBLY

Unlike our previous ass'y this one comes with a 1L insulated tank for cooling water. As used in gravity fed water coolers.. The tank can be easily removed for refrigerator applications but some additional metal plate/heatsink may be required. Complete 12V assembly including the heatsinks, fan, peltier & the tank: $37.

240V-12V power supply PCB suit the above cooler / heater: This PCB can be connected to the thermistor which is in the tank so that the temperature is controlled. **DANGER HIGH VOLTAGE: FOR QUALIFIED PERSONS ONLY**

(USED) 50MHz DUAL TRACE OSCILLOSCOPE

With DELAYED TIME BASE: Telequipment brand, model # D83. Plug-ins V4 & S2A. Used but in good condition. (ZC0465)$280

Check our web site for more CRO other test equipment bargains.

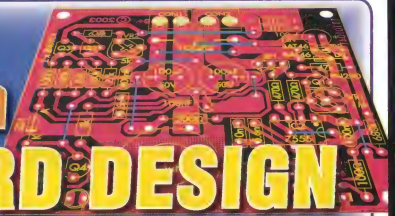
And don't forget to subscribe to our bargain corner to be notified of the latest bargains

www.oatleyelectronics.com OR www.oatleye.com Suppliers of kits and surplus electronics to hobbyists, experimenters, industry & professionals.
Orders: Ph (02) 9584 3563, Fax 9584 3561, sales@oatleyelectronics.com, PO Box 89 Oatley NSW 2223

major credit cards accepted, Post & Pack typically $7 Prices subject to change without notice ACN 068 740 081 ABN18068 740 081

SC_MAR_04

Hands-On PC BOARD DESIGN For Beginners; Pt.2



This month, we describe how to use the basic features of Autotrax to create a simple PC board design. Along the way, you'll learn about layout defaults, placing components and routing tracks. You'll also learn how to edit and create your own component libraries.

By PETER SMITH

BOTH THE MOUSE and keyboard can be used to navigate the menu structure and edit board layouts within Autotrax. In practice, you'll use a combination of both. Let's see how it works.

The main menu is displayed by pressing <Enter> or clicking <Left Mouse>. Selections within the menu are then made either with mouse movement or with the arrow keys. To exit the menu at any point, hit <Esc> or click <Right Mouse>.

It is also possible to navigate the menus by simply keying in the first character of the desired entry. For example, pressing <F> <Q> <Y> in sequence is equivalent to selecting *File -> Quit -> Yes* from the menu.

A number of often-used menu items can also be accessed using control keys. For example, holding down <Ctrl> and pressing <P> jumps to *Current -> Pad Type*.

A list of the commonly used shortcut keys appears in Table 1.

Note that once selected, editing functions (such as pad/track placement) remain active until after you've hit the <Esc> key or clicked <Right Mouse>. However, you can switch active layers with the <+> and <-> keys on the numeric keypad or change the zoom level with <Z> even while in edit mode.

Setting options

Shortcut keys, layer and menu colours and a whole host of other editing functions can be customised from within Autotrax's Setup menu (Fig.1).

To get to the *Setup* menu, start Autotrax and press <Esc> when prompted to load a PCB file. Next, press <Enter> to display the main menu and choose *Setup* from the list, or simply press <S>. To get up and running with your first design, you need only review the settings within two out of the 10 menu entries (see Figs.2 & 3). The remaining options can remain at their defaults for now.

Now back at the main menu, press <C> to display the *Current* menu. Settings here determine the defaults used when laying down your design. Many of these will be changed "on the fly", as the design progresses. However, the grid must always remain set to "Imperial" and the floating origin to "0,0". Fig.4 shows typical defaults.

Many of the *Current* settings are displayed along the status line at the bottom of the screen. These are interpreted as follows: **L** - layer, **P** - pad type, **T** - track width, **S** - string size, **G** - snap grid. The **X** & **Y** values show the current cursor position in thousandths of an inch.

Grid size

Next, press <G> to set the grids. We recommend 25 thou for the snap grid and 100 thou for the visible grid. Generally, you should leave the snap grid set to 25 thou throughout the design. This is a very important requirement. If a board is routed on different grids, it will be difficult to get tracks and pads to "snap together" nicely.

It will also make it much more difficult to maintain minimum manufacturing clearances between tracks/pads.

On occasion, a finer grid will be needed for working in tight areas, or when connecting metric-leaded components, for example. In this case, step

down to a 5-thou snap grid just for the particular area of interest.

Defining the board outline

Elsewhere in this article, you'll find details of a simple PC board design (for a power supply) that we've created to help demonstrate the essentials. Rather than "pulling apart" the completed design, let's start at the beginning – and recreate the design from scratch.

The first task is to define the board outline. For any project, board shape and size will depend on the number and size of components, as well as the dimensions of the enclosure (if any) that you wish to fit the final product into. Our power supply will be a freestanding module, without an enclosure. Therefore, the initial board size is just an educated guess and can be adjusted at a later stage if necessary.

The board outline is drawn on the top overlay, using a 10-thou track width. To do this, first check the current layer and track size, which you'll remember is always visible on the status line. Use the <+> key on the numeric keypad to switch from the bottom layer to top overlay if necessary. To change track width, simply hit <Ctrl + T>.

Press the <P> then <T> keys to enter track placement mode and position the cursor at the bottom left of the work space (X:0, Y:0). Click <Left Mouse> to start laying the track. Move in a vertical direction for 2.7" (X:0, Y:2700), then click <Left Mouse> again. You'll probably need to zoom in to get a closer look; hit <F6> to move closer, <F5> to move away or <F10> to fill the screen with your work thus far.

Now move in a horizontal direction for 1.45" (X:1450, Y:2700) and click <Left Mouse> again. This completes the left side and one end of the board outline. Continue the track down the right side and opposite end to form a complete rectangle.

If you make a mistake, first press <Esc> or click <Right Mouse> to exit track placement mode. Next, press <D> <T> and click on the track to delete it. When done, press <Esc> again to exit track deletion mode.

Deleting and replacing tracks is just one way of editing a design. In most cases, it is quicker to edit the track position (or its end point or route). This can be achieved with the *Track, Drag End* and *Re-route* commands, accessible via the *Move* menu. In addition, track widths can be changed using the *Edit -> Track* command.

Note that as with all operations in Autotrax, you can use the keyboard as well as the mouse to place and edit components and primitives (tracks, pads, etc). The arrow keys move the cursor around, and the <Enter> key is equivalent to a left mouse click.

Fig.1: design defaults and user preferences are accessible via the *Setup* menu.

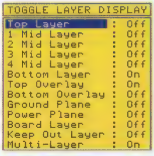


Fig.2: the *Toggle Layers* menu allows you to switch on only the layers that you need. As shown here, single-sided designs require only the Bottom Layer, Top Overlay and Multi-Layer enabled.

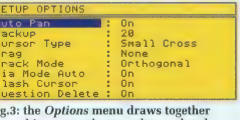


Fig.3: the *Options* menu draws together several important but mostly unrelated controls. For example, the *Drag* option determines how Autotrax handles tracks connected to a component when you move it. *Track Mode*, on the other hand, determines whether Autotrax enforces orthogonal track placement. Use the settings shown here as a starting point.

Loading the library

Autotrax is supplied complete with a library of commonly used components (TRAXSTD.LIB). Unfortunately, this library is unsuitable for use without major editing. Many pads are too small for non-plated-through (single-sided) designs and the hole sizes don't equate to the metric drill sizes commonly used in Australia.

We'll describe how to edit and create your own libraries a little further on. For the moment, use the SIMPLE.LIB library that we've built especially for this design. It can be obtained from the SILICON CHIP web site (see panel entitled "Power Supply Demo Design").

To load a new library file, press <L> to bring up the *Library* menu, then <F> to get the file name prompt. The file shown will be the currently loaded library, in this case C:\AUTOTRAX\TRAXSTD.LIB. Change this to read C:\AUTOTRAX\SIMPLE.LIB and press <Enter> to load it.

Initial component placement

For a typical design, we would now need to check that a matching "footprint" exists in the library for each unique component in the parts list. As SIMPLE.LIB already contains all of the relevant footprints, we can skip this step and go straight to placement.

Table 2 lists all the components in this design together with the matching footprints in SIMPLE.LIB. Let's begin by placing the three resistors (R1, R2 & R3).

Press the <P> then <C> keys and you will be prompted for the name of the component to be placed. By default, the name of the last component used is displayed. You can simply press <Enter> to place the same component again, or type in the desired component name directly. You can also change the name to a question mark (?) and press <Enter> to see a list of all footprints in the library (Fig.5).

If using the latter method, highlight "RES0.4" in the list (determined from Table 3) and press <Enter>. For "Component Designator", enter "R1", and for "Comment", enter the component's value, which in this case is "120R" (we've used "R" instead of the "Ω" symbol). You can now move the re-

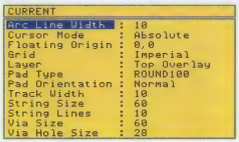


Fig.4: the *Current* menu primarily defines the current primitive sizes. For example, if you were to hit <P> <P> to place a pad, you'd get 100 thou round pads using these settings. Leave the "Floating Origin" and "Grid" options set as shown here.

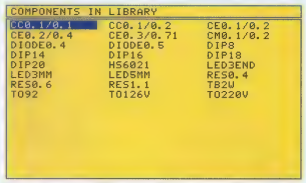


Fig.5: using the *Library -> List* command lists all of the components in the currently loaded library – in this case SIMPLE.LIB.

sistor around the board and drop it by pressing <Enter> or clicking <Left Mouse>. For the moment, place all components just outside the board outline.

Note that as soon as you drop the resistor, you'll be prompted to place another. Simply follow the same procedure to place R2 and R3, entering the appropriate resistance values (from Fig.8) in the "Comment" field.

That done, load all the remaining components using the circuit diagram (Fig.8) and footprint list (Table 2) as your guides. The final result should look something like that shown in Fig.6.

Mounting holes

If mounting holes are required, place them next; trying to fit them in later can be a real pain! For a typical 3mm screw & stand-off combination, use a 220-thou round pad with 120-thou hole. This large pad size ensures that they'll be enough clearance around the spacer (or nut) and screw head during assembly.

In the demo design, we initially placed a hole at each corner but were later able to move the bottom pair up into unused space. This reduced the board length by about 10mm.

Doing the shuffle

Now the real work begins! Obviously, the aim is to arrange the components within the board outline so that it will be possible to connect them as shown on the circuit diagram. Press the <M> and then <C> keys and click on a component to pick it up. To rotate the component left by 45°, hit the space bar. As before, press <Enter> or click <Left Mouse> to drop it.

So how do you know where to place each part? Well, in all but the simplest of designs, you'll need to move components around after the initial placement to "get the right fit". In some cases, you may even need to "rip up" your design (tracks and all) and redo it a number of times!

Experience has a lot to do with it too. The more layouts you do, the quicker you'll be able to find a layout that works. Our recent PC Board Design Tutorial series (Oct. – Dec. 2003) will really help from here on. Much of the information presented in the series is not duplicated here, so it should be considered mandatory reading.

Don't cram all the components close together; adjacent components must not physically interfere with one another. Some layouts will progress faster if you initially leave at least enough space to fit a 30-thou track between adjacent component pads.

Table 1: Handy Shortcuts

Key Sequence	Command
<Ctrl + G>	Current -> Grid
<Ctrl + P>	Current -> Pad Type
<Ctrl + Q>	File -> Quit
<Ctrl + S>	Current -> String Size
<Ctrl + T>	Current ->Track Width
<F1>	Place -> Pad
<F2>	Delete -> Pad
<F3>	Place -> Track
<F4>	End track
<F5>	Zoom -> Contract
<F6>	Zoom -> Expand
<F7>	Move -> Re-Route
<F8>	Delete -> Track
<F10>	Zoom -> All

<+>, <-> and <*> keys on the numeric keypad can be used to cycle between defined layers.

Laying the tracks

To begin the layout, hit <Ctrl + T> and select a 70-thou track width. Check that you're on the bottom layer, and then press <P> followed by <T> to enter track place mode.

To reposition tracks after initial placement, use the *Break*, *Drag End*, *Re-route* and *Track* commands, accessible via the *Move* menu. Place a couple of tracks and experiment with these commands now – you must be completely familiar with how they work. Remember that you can zoom in and out with the <Z> command, even in edit mode!

We used 70-thou tracks for most of the design, increasing to 100 thou for the main current-carrying conductors. Notice how we had to "neck down" from 100 to 70 thou to connect to REG1. Two overlapping 100-thou tracks form part of the ground connection. Where space permits, it's a good idea to use as much copper as possible for high-current rails.

Although not particularly evident on this simple design, it's important to constrain track placement to 0, 45, 90, 135, 180, 225, 270 or 315-degree orientation. This is called "orthogonal" placement and it makes maintaining consistent track-to-track and track-to-pad clearances easier. The "Track Mode" setting in the *Options* menu can be set to "Orthogonal" to automatically enforce this mode. However, some users prefer to set this option to "Non-ortho" and align tracks by eye, as the auto mode makes track placement less predictable.

Another method is to initially route

all the tracks with 90° corners. This works well on simple, uncluttered designs. Once the layout is almost complete, go back and put in 45° corners ("chamfers") using the *Re-route* command. The result is more pleasing to the eye and it helps to prevent undercutting during etching.

Track to pad joints

Generally, tracks should be routed all the way to the centre of pads. Also, when laying multiple tracks together to make a wider copper area, make sure that there is a sizeable overlap.

Autotrax draws pads on top of tracks, so obscuring where tracks actually end. Once you've completed your layout, check for inconsistencies by changing the track and pad redraw mode to "Draft". You'll find this option in the *Setup - > Redraw* menu.

Strings

Strings (free text) can be placed on most layers. To enter a string, press the <P> and then <S> keys and type in the text. When complete, press <Enter> or click <Left Mouse> and you're ready to place it. At this point, you can rotate the string by pressing the space bar, flip it with the <Y> key or reverse it (for the bottom layer) with the <X> key.

On copper layers, allow at least 10 thou clearance between strings and other objects (tracks, pads, etc) to avoid potential shorting/etching problems. A 5-thou snap grid allows accurate placement.

The default string size can be changed via the *Setup -> Strings* menu, although 60 thou is recommended for most work. Strings can be edited (moved, sized, etc) via the *Move -> String, Edit -> String* and *Delete -> String* menu commands.

All components include two "special' strings; the "designator" and "comment". These can be moved about just like free strings but cannot be edited or deleted with the string commands mentioned above. Instead, you must edit them via the *Edit -> Component* menu.

Note that whenever you edit a component and change the display mode for either of these strings from "Show" to "Hide" (or vice versa), you have the option of applying the change globally. To reduce clutter, some users prefer to hide all of the component comments (or designators, depending on design complexity) until after most of the work is done. It's also possible to determine whether the "designator" and "comment" strings are hidden or displayed during initial component placement – see the *Setup -> Component Text* menu.

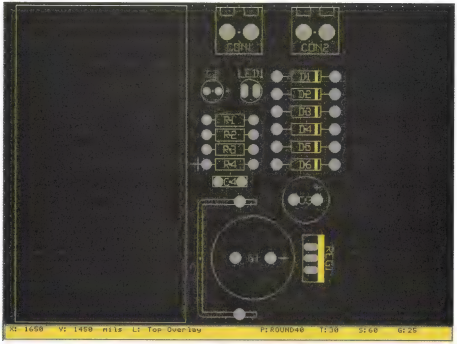


Fig.6: once the board outline has been drawn, load all the components and temporarily position them outside the outline. Notice that we've initially hidden all of the component "comment" strings.

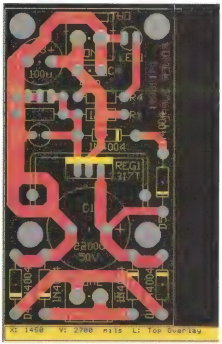


Fig.7: our completed layout. Notice how the strings on the bottom layer have been "flipped".

Block operations

The *Block* menu commands allow you to move, copy or delete an entire section of your design at once. Anything that can be selected within a rectangular border can be acted upon *en masse* by these commands. In addition, block commands are used when creating new library footprints (see **Libraries** further on).

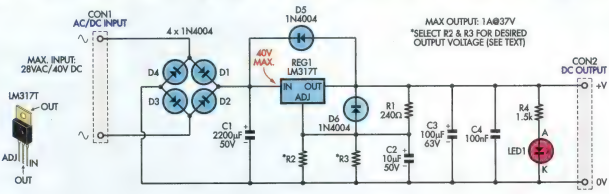
Before using any of the block commands (except *Hide* and *Read*), you must first define the block. Press the <B> and then <D> keys and move the cursor to the first corner of the desired area. Click <Left Mouse> or press <Enter> and move the cursor to the opposite corner. A rectangular outline expands behind the cursor as it is moved, indicating the selection area. Click <Left Mouse> again to lock in the selection. Finally, choose a reference point. This will be used as the axis for the move and copy commands.

In addition to move, copy and delete, you can also write the defined area to disk as a .PCB file. This can be retrieved later using the complementary *Read* command. Block operations should be used with caution; always, *always* save your work first!

Saving your work

Whenever editing a design, save your work regularly via the *File -> Save* menu. It's also a good idea to save a backup copy of your work before starting a new editing session.

Power Supply Demo Design



SIMPLE DC POWER SUPPLY

Fig.8: a complete and accurate circuit diagram is required before you attempt even the simplest of layouts. Here's the circuit for a simple DC power supply that we've used as our demo design. It uses a conventional 3-terminal regulator, with the output voltage programmable via resistors R2 & R3.

Although Autotrax includes a demonstration design (DEMO.PCB), it is far too complex to be of use to the first-timer. We decided instead to create our own simple design, the layout for which appears in various stages throughout this article. The complete circuit and overlay diagrams appear in Figs.8 & 9.

You can download the design (PSU.ZIP) from the SILICON CHIP web site at **www.siliconchip.com.au** – look in the software download area. This file also includes the SIMPLE.LIB library referred to in the text. Unzip PSU.ZIP into your C:\AUTOTRAX directory.

How it works

The Simple DC Power Supply is based around the well-known LM317T 3-terminal adjustable voltage regulator. These devices are extremely robust, having in-built over-temperature and over-current protection.

The supply can accept an input of up to 28VAC or 40VDC and provide a well-regulated DC output in the range of 1.2V to 37V. Output current is 1A maximum and depends on the input to output voltage differential.

Using the specified heatsink and at room temperature (25°C), The LM317 can safety dissipate 2.5W of power. You can use this power level to calculate the maximum output current for a given input to output differential.

For example, with 16V at the input to the regulator and 5V at the output, the maximum current is:

$$I_{OUT(MAX)} = PD_{MAX}/(V_{IN} - V_{OUT}) = 2.5W/16V - 5V = 0.227A$$

The output voltage can be programmed by selecting appropriate values of R2 & R2, according to the formula:

$$V_{OUT} = 1.25 \times (1 + (R2||R3)/R1)$$

A list of commonly used voltages and the corresponding values for R2 and R3 appear in the above Table.

Alternatively, you can install a miniature 5kΩ multi-turn potentiometer in place of R2 & R3 for a 1.2V to 27V

R2 & R3 Values For Common Output Voltages

Output Voltage	R2	R3
3V	1.2kΩ	470Ω
5V	3kΩ	-
6V	11kΩ	-
7.5V	1.2kΩ	-
9V	3.3kΩ	2.7kΩ
12V	3.3kΩ	5.6kΩ
15V	3.9kΩ	8.2kΩ

Autotrax automatically saves a backup copy of your work for disaster recovery purposes. You can change the backup interval (in minutes) and the filename used via the *Setup -> Options* menu. An interval of between 10 and 20 minutes is typical.

Loading the demo design

With the information presented thus far, you should be well on your way to completing the demo design. Alternatively, if you'd rather load the "one we prepared earlier" and experiment with that instead, then follow the instructions in the "Power Supply Demo Design" panel to download and install the relevant files.

So you've finished the board layout – what now? Well, the following half of this article describes several concepts and features of Autotrax that will help you to get started with your own creation!

Multiple layers or wire links?

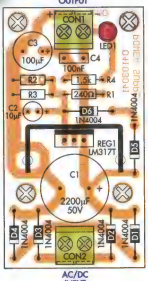
A good single-sided PC board design is one that requires no wire links – or so we've heard. The reality is that no matter how proficient you become,

Parts List

1 PC board, code 04103041, 36.8mm x 68.6mm
1 LM317T adjustable positive voltage regulator (REG1)
6 1N4004 1A diodes (D1-D6)
1 5mm red LED (LED1)
2 2-way 5.08mm-pitch terminal blocks (CON1, CON2)

Capacitors
1 2200µF 50V PC electrolytic
1 100µF 63V PC electrolytic
1 10µF 50V PC electrolytic
1 100nF 63V MKT polyester

Resistors (0.25W 1%)
1 1.5kΩ R2 (see table)
1 240Ω (R1) R3 (see table)



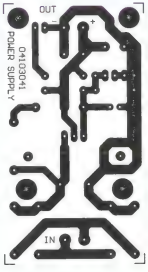


Fig.9: companion overlay diagram for the completed design. You can purchase a ready-made PC board from RCS Radio at www.rcsradio.com.au if you would like to build one, or wait until next month to find out how to make the board yourself!

adjustment range.

Note that the voltage at the input terminal of the 3-terminal regulator (REG1) must be at least 2V higher than the programmed output voltage.

some of your designs will require links to make those last few connections.

Of course, depending on complexity, a two-layer (or more) design might also be the answer, especially if you have limited space to work with. Multiple-layer designs are for experienced designers only, so we won't cover them here!

Typically, a link is just a straight piece of wire with a pad at either end. We recommend a minimum pad size of 70 thou (85 thou preferred) with a 28 or 32-thou hole. Draw a track between the two pads on the component overlay to indicate the link position.

To give the assembled board a professional appearance, wire links should be oriented and aligned with surrounding components (they should not straddle or otherwise interfere with them!).

If you wish, you can disguise you links by using zero ohm resistors instead of plain old tinned copper wire. These are available in standard "1/4W" package styles from the usual electronics outlets.

Fills and arcs

Large copper areas are easily created with the *Place -> Fill* command and edited in a similar manner to the previously described "primitives" (pads, tracks, strings, etc). Fills should be used in place of multiple overlapping tracks wherever possible, as editing is far more efficient.

Autotrax supports arcs of any diameter and width with one to four quadrants. Avoid these on the copper layers unless you know what you're doing.

Libraries

As mentioned previously, the standard Autotrax library (TRAXSTD.LIB) is unsuitable for use without major editing. One option is to obtain a complete set of libraries on CD-ROM from RCS Radio. These are supplied "ready to go" and are optimised for use on non-plated through board layouts. Contact Bob Barnes on (02) 9738 0330 or check out **www.rcsradio.com.au** for more information.

An excellent component library is also available from Airborn Electronics at **www.airborn.com.au/layout/autolib1.html**. Note that this library is optimised for plated-through (double-sided) board design. This means that the pad sizes (for through-hole components) are too small for use on single-sided boards. However, you can readily use it as your reference library, editing footprints as required and adding them to your own library.

Building your own library

Library components are made up of all the familiar primitives. However, their individual elements are not free to move; they're bound together in a fixed relationship to one another. We can break that relationship, edit the individual primitives and then regroup them again at will. Let's experiment with an existing component from SIMPLE.LIB.

First, find some free space (anywhere outside the border) of the power supply demo design if you

Table 2: Component Designators & Matching Footprints In SIMPLE.LIB

Component	Library Footprint
C1	CE0.3/0.71
C2	CE0.1/0.2
C3	CE0.2/0.4
C4	CM0.1/0.2
CON1-CON2	TB2W
D1–D6	DIODE0.5
LED1	LED5MM
REG1	TO220V
R1-R4	RES0.4
HEATSINK	HS6021

Table 3: Use These Hole Sizes In Your Designs

Design Size (thou)	Drill Size (mm)
120	3.00
80	2.00
60	1.50
50	1.20
40	1.00
36	0.9
32	0.8
28	0.7
24	0.6

have it open, or start a new design. Make sure that the snap grid is set to 25 thou and place a "RES0.4" component from the library. Next, "explode" the component by selecting the *Library -> Explode* menu command and clicking on it. "Exploding" the component simply means converting all of its primitives to free (unbound) elements.

You can now edit the pads and tracks that form the outline (on the overlay) just like any other free primitives. To prove the point, change the pad sizes to 120 thou now using the *Edit -> Pad* command.

That done, let's save the modified footprint back to the library as a new component. First, use the *Block -> Define* command to select just the desired primitives. For a reference point, you can either click exactly in the centre of the component or in the centre of one of the pads. This will be the axis point when placing the component from the library later.

Next, select *Library -> Add* from the menu. You'll then be prompted for a name for the new component. Type in "RTEST" and press <Enter> and you've successfully created your first component!

Once you've created the new component, the original "exploded" component remains. As it's still highlighted (defined inside a block), you can quickly remove it with the *Block -> Inside Delete* command. Of course, you could also use *Block -> Hide* and delete the primitives individually!

The *Library* menu provides a host of other functions. You can rename and delete components, merge libraries and create new libraries. The *Compact* function should be used after editing to tidy up the internal file structure.

Important: a library must never have more than 200 components. If you attempt to add more than 200 components, your library will be corrupted! Always save a backup copy of a library before editing it!

Pads, tracks & hole sizes

For single-sided board design, the minimum pad size to use with through-hole components is 70 thou, with 80 or 85-thou recommended. Other typical sizes are 100, 120 (or 125) and 150 thou. Stick with round or square pad shapes.

The library components must closely match the physical size, footprint and lead diameter of the real components. You can get the necessary information from the manufacturer's data sheets or measure the components yourself using Vernier callipers. Callipers with an LCD display make this job even easier.

Single-in-line (SIL) and dual-in-line (DIL) packages with 0.1-inch pitch pins (ICs, for example) are an exception. The recommended minimum size for these is 60 x 120 (rounded rectangles). Never use round pads for this job – they may well lift off the board as soon as they're heated!

It is important that the holes sizes used in your designs closely translate to the commonly used metric drill sizes used here in Australia – see Table 3 for a list of typical hole sizes. An exception to this rule would be if your boards were being made in the US. In this case, refer to the manufacturer for their requirements. This is something that you should always do before submitting your designs anyway – it might save you a lot of money!

For a handy one-page summary of recommended track, pad and hole sizes, get a copy of RCSTRAXY.PCB, available free from RCS Radio at **www.rcsradio.com.au**

Advanced topics

Autotrax includes the ability to automatically place components and route all or part of your designs. Experienced users would probably agree that this feature is of limited use. Manual placement and routing always gives a better result!

If you want to experiment with these features, you'll need a netlist of your design. Netlists are usually generated by schematic capture software. They describe all of the components in a design as well as how they are connected.

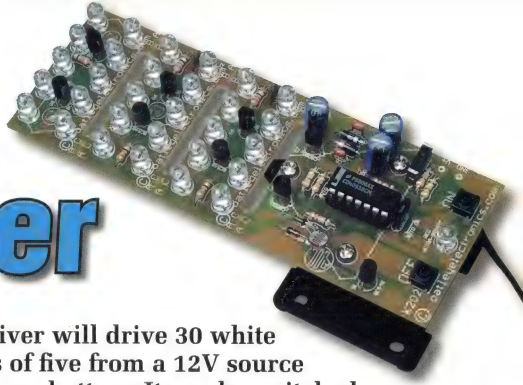
Our simple power supply design includes a netlist file (PSU.NET) that can be loaded using the *Netlist -> Get Nets* command. Once loaded, you can turn on the "rats nest" display using *Netlist -> Show -> All* Nets.

Note that before using any of the auto place or route functions (see the *Netlist* menu), you must define the board outline on the "Board" layer. To do this, first turn on the Board layer via *Setup -> Toggle Layers*. Next, switch to the Board layer and duplicate the outline drawn on the Top Overlay.

Next month

Next month, we'll show you how to make a hardcopy of your design. This will enable you to check that all the components will fit on your completed board. It can also be used to make your own PC boards at home! SC

LED Driver



This white LED driver will drive 30 white LEDs in six groups of five from a 12V source such as an SLA or car battery. It can be switched on and off manually or it can switch on automatically when darkness falls.

By STEPHEN DAVID

WHILE WE HAVE now published quite a few LED driver circuits, to date we have not published a design to drive a bunch of high-brightness white LEDs. Such a circuit is now quite desirable as the price of white LEDs has fallen and you can have a handful for not a lot of dollars.

However, white LEDs do present a problem because they need a higher drive voltage than monochromatic types such as red, green, orange etc. Instead of around 1.8V to 2V or thereabouts, they normally require more than 3V to produce their rated brightness. In fact, if you are driving a bunch of them you need to drive them all at constant current otherwise their individual brightness tends to vary markedly.

However, if you only have a 12V supply available, you can only put two or maybe three LEDs in series together with a constant current source and this leads to poor efficiency.

The approach in this circuit is to boost the 12V supply to something around 21V and this means that we can have groups of five LEDs, each in series with their own current source transistors.

The result is a single PC board with the drive circuitry and 30 white LEDs. It can be used for lighting in caravans and recreational vehicles, emergency lighting or whatever application you can think of. Current drain is around 190mA at 12V.

Where To Buy A Kit

This kit has been designed by Oatley Electronics who own the copyright. The kit comes in two parts:

(1) K202 which includes the PC board, the driver circuitry, 10 high brightness white LEDs and two current source transistors; and

(2) K202A which provides 10 high brightness white LEDs and two current source transistors, so with K202 and two K202A kits you get the full complement of 30 white LEDs.

Pricing is $17 (including GST) for K202 and $8 for K202A. The optional swivel mounting bracket is $1.00 while postage and packing is $6 within Australia. Kits may be obtained direct from Oatley Electronics, PO Box 89, Oatley NSW 2223. Phone (02) 9584 3563; Fax (02) 9584 3561. Website: **www.oatleye.com**

Circuit description

Now let's have a look at the circuit of Fig.1. It uses just one IC (a 4093 quad NAND Schmitt trigger gate package), a few transistors and diodes, 30 white LEDs and not much else.

So where is the familiar boost converter circuit? Answer: there isn't one or least not one with an inductor switched by a Mosfet. Instead, there is a charge pump inverter, comprising IC1c, transistors Q2 & Q3, Schottky diodes D1 & D2 and a few capacitors. It works as follows:

IC1c is connected as an inverter oscillator and its running frequency

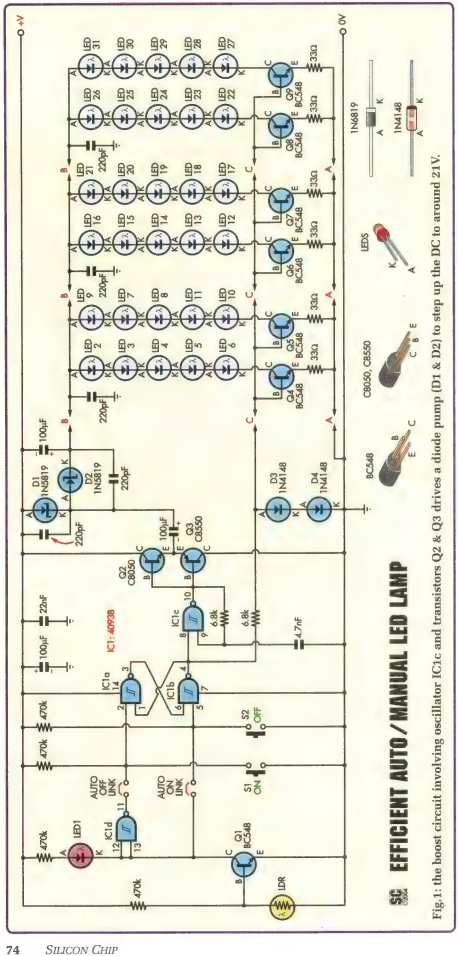


Fig.1: the boost circuit involving oscillator IC1c and transistors Q2 & Q3 drives a diode pump (D1 & D2) to step up the DC to around 21V.

of about 30kHz is determined mainly by the 6.8kΩ resistor between pins 8 & 10 together with the 4.7nF capacitor at pin 8. This produces a rectangular waveform (not quite square but pretty close) at pin 10 to drive complementary switching transistors Q2 & Q3.

The waveform at their commoned emitters drives a diode pump consisting of two 100µF capacitors and Schottky diodes D1 & D2. The waveform generated by the circuit can be seen in the scope photo of Fig.2.

RS flipflop

Oscillator IC1c is controlled by an RS (Reset/Set) flipflop comprising the two NAND gates IC1a & IC1b and this is controlled by pushbutton switches S1 and S2. Normally, this has its pin 4 low and pins 1 & 6 are pulled high via 470kΩ resistors. Momentarily closing S1 (ON) pulls pin 6 low, causing the flipflop to change state so that pin 4 now goes high to enable IC1c which now oscillates at 30kHz.

The 30kHz waveform produced by transistors Q2 & Q3 drives the diode pump referred to earlier and this develops about 21V to drive the LED columns.

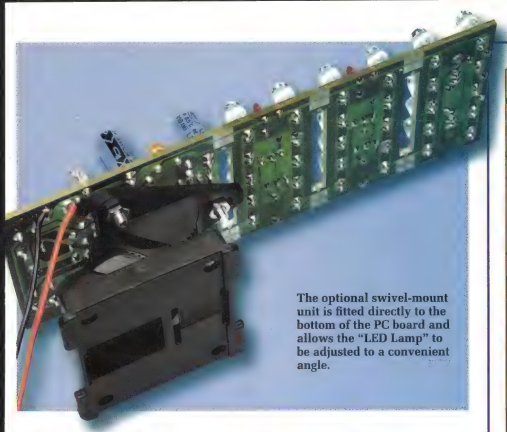
Each column of five white LEDs is driven by its own current source transistor which has a 33Ω emitter resistor. The bases of all six current source transistors (Q4-Q9) are driven from pin 4 of IC1b via a 6.8kΩ resistor and clamped to a maximum of +1.2V by diodes D3 & D4. Subtract the 0.6V between the base and emitter of each transistor and you are left with 0.6V across each 33Ω resistor, thus setting the LED drive current to 18mA.

Switching the circuit off is accomplished by pushing the OFF switch, S2. This momentarily pulls pin 1 low to toggle the RS flipflop, thus causing pin 4 to go low. This disables IC1c, Q2 & Q3 and also turns off the current source transistors.

Note that there is an interesting wrinkle to this drive circuit, because there is no On/Off switch. This means that the current source transistors must be turned off otherwise they would continue to draw current from the 12V supply even when the circuit is nominally off. The current path may not be obvious but it is via the boost circuit's diodes, D1 & D2.

Auto on/off

As well as using the pushbutton



The optional swivel-mount unit is fitted directly to the bottom of the PC board and allows the "LED Lamp" to be adjusted to a convenient angle.

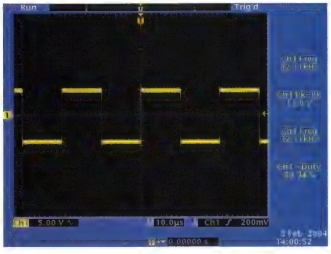


Fig.2: this scope shot shows the waveform at the commoned emitters of transistors Q2 & Q3.

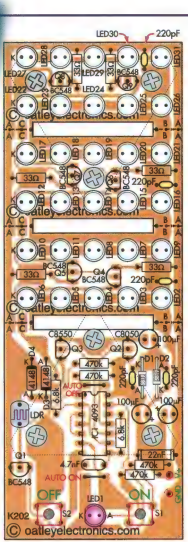


Fig.3: the component overlay for the PC board. Sections can be snapped off to provide "lamps" at separate locations.

switches S1 & S2 to turn the circuit on and off, there is also a facility to automatically turn the circuit on and off depending on ambient light levels. Links L1 & L2 can be used to provide Auto On and Auto Off respectively and these features can be used separately or together.

An LDR (light dependent resistor) is used to monitor the ambient light level. When light falls upon it, it pulls the base of Q1 low, causing pins 12 & 11 of IC1d to go low and its pin 11 to go high. When darkness falls (or the room lights go out), the process is reversed. Depending on whether you have one or both links connected, you can use the pushbuttons to turn the circuit on and off and have it turn on and/off automatically as well.

Q1 also drives a red high brightness LED (LED1) at very low current, via a 470kΩ resistor. This is a bit of a gimmick but it does have the benefit of showing that this part of the circuit is working, if you have to trouble-shoot it.

Board options

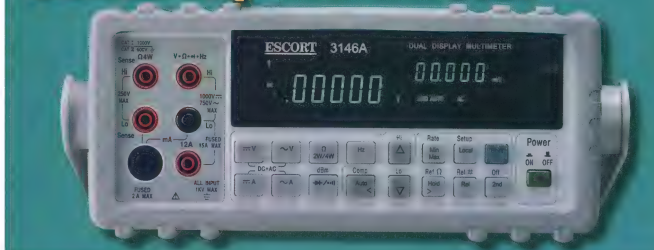
As presented, the PC board is 130 x 47mm and it has three snap-off sections, each carrying 10 LEDs and two drive transistors. This gives you the option of having all 30 LEDs on the board or having three separate LED "lamps" spread around your tent, caravan, boat, yurt or whatever. You would need three wires to interconnect each board section, if you take that option.

The full board component overlay is shown in Fig.3 and it shows a full complement of 30 LEDs (plus red LED1).

No special order of assembly is necessary but take care to insert all the polarised components correctly. Note the little flat on one side of the LEDs; this needs to match the screen-printed overlay on the PC board.

Make sure you connect the supply wires correctly. Reversing them will almost certainly cause component damage. **SC**

Review: Escort 3146A Bench Top Multimeter



Test engineering and research and development work often calls for high-accuracy, high-resolution digital measuring instruments. Bench top multimeters typically used in these applications are very expensive – until now, that is. These new meters from Escort "break the mould" by offering remarkable performance at a relatively low price.

By PETER SMITH

THE COST OF these new bench top multimeters is so attractive that they seriously challenge the pricing of top-of-the-line hand-held digital multimeters. Unless portability is a "must have" on your feature list, why would you buy another handheld? Check out these specs: 5½ digits (120,000 count) display resolution, 120ppm (.012% + 5 digits) basic DC accuracy and 1µV to 10mV DC sensitivity.

Including the protective holster, the 3146A measures about 255 (W) x 105 (H) x 305mm (D) and weighs slightly less than 3kg.

Measurements include DC voltage and current, true RMS AC & AC+DC voltage and current, resistance, frequency, diode test and continuity test. Bandwidth for true RMS voltage measurements is 20Hz to 100kHz. Detailed specifications are presented in the accompanying panel.

In addition to the basic measurements, a number of useful arithmetic functions can be applied to many of the readings. For example, when measuring AC or DC volts, a modifier can be applied to display power in dBm with respect to a reference impedance. The impedance is selectable in 21 ranges from 2Ω to 8000Ω.

Other functions include "compare", "relative", "minimum", "maximum" and "hold", many of which can be combined. For example, if "dBm" and "relative" are selected, the result of the dBm calculation becomes a relative base for new measurements.

These meters have five input terminals rather than the three (or four) typically provided on lower performance models. The extra two terminals are for the "sense" lead connections in a four-wire ("Kelvin") resistance measurement scheme. Using four leads results in double the accuracy that can be achieved with just two leads; as high as 0.05% on the 120Ω scale. Of course, conventional two-wire resistance measurements are also supported.

The bottom sense terminal is also used as the positive terminal for current measurements on the mA ranges. In addition, this terminal can be used in conjunction with the main positive and negative terminals to perform 3-wire, simultaneous current and voltage measurements. This could be useful for measuring power in a circuit or the gain of a transistor, for example.

Dual VFD display

While liquid crystal displays are preferred on portable instruments due to their low power consumption and minimal space requirements, bench top instruments generally employ either LED or vacuum fluorescent displays (VFDs). This meter uses a large, blue VFD that is very easy to read, regardless of lighting levels or viewing position.

The VFD incorporates dual readouts that enable simultaneous display of two measurements. The primary (larger) display is always active, whereas the secondary (smaller) display can be programmed to display almost any of the available measurements.

Specifications (3146A)

Basic DCV accuracy of 120ppm

120,000 / 40,000 / 4000 count display resolution (selectable)

2/sec (120,000), 5/sec (40,000), or 20/sec (4,000) measurement rate (selectable)

DCV Range from 120mV to 1,000V with 1μV max. resolution

ACV Range from 120mV to 750V with 1μV max. resolution

DCA and ACA range from 12mA, 120mA, 1.2A to 12A with 100nA max. resolution

True RMS AC and AC+DC measurement, ACV 20Hz-100kHz & ACA 20Hz-10kHz

Resistance measurement range from 120Ω to 300MΩ with 1mΩ max. resolution

2-wire or 4-wire resistance measurement

Frequency measurement range from 1200Hz to 1MHz with 0.01Hz max. resolution

dBm measurement with 0.01dBm resolution and reference impedance from 2Ω to 8000Ω

Diode and audible continuity test functions

Auto or manual ranging

Relative mode for zeroing offset

Dynamic min./max. recording

Compare (High/Low/Pass) function for quick in-tolerance tests

Data hold function to freeze readings

Standard RS-232 interface

Optional GPIB interface

19-inch rack mountable with rack mount kit

Fast electronic and closed-case calibration

Meets IEC-1010-1 600V CAT II and 1000V CAT I and CE mark

Escort 3136A – even better value!

So the 3146A looks great, but it's still outside your budget? Then check out the lower cost 3136A model! It has a display resolution of 4½ digits (50,000 count), a basic DC accuracy of 200ppm (.02% + 4 digits) and a DC sensitivity of 10μV to 100mV. It includes true RMS AC & AC+DC measurements, with an ACV bandwidth of 30Hz-100kHz and an ACA bandwidth of 30Hz-20kHz.

Although it has lower resolution and accuracy, the 3136A boasts many of the same features as its bigger brother, including a dual VFD, dBM measurement capability and RS232 interface as standard.

For more technical information on the 3136A, check out Escort's web site at **www.escorttw.com**

The display can be programmed to update 2, 5 or 20 times per second. Display update speed correlates directly with resolution. At five updates per second, the resolution is reduced to 40,000 count, whereas at 20 updates per second, it's just 4000. High-speed sampling is probably most useful in automated testing, made possible via the communications interfaces (see "RS232 interface" below).

On a more basic level, high-speed sampling also makes for virtually instantaneous continuity testing, something that is missing on most of the not-so-cheap microprocessor-based hand-held multimeters!

Front panel controls

An array of 16 "soft feel" push-button switches is provided for the user interface. Most of these perform two roles, the second of which is enabled by pressing a "shift" key first.

Unlike some instruments we've seen, these meters are relatively easy to drive. Function selections are quite intuitive, with basic measurements possible without so much as a glance at the operation manual. Nevertheless, we do admit to reading the manual before using some of the more advanced arithmetic functions!

RS232 interface

An RS232-compatible serial interface is included as standard. Essentially, any reading that can be performed at the front panel can also be performed over the serial interface using simple ASCII-encoded sets of commands and responses.

At the most basic level, "key" commands can be sent over the interface to simulate front-panel keystrokes. A more involved method uses "set" commands, which control the meter using coded character strings. To retrieve meter readings and instrument status, the "query" group of commands is used.

In order to make use of the serial interface, you can either purchase the optional PC link software (not reviewed) or write your own custom applications. An example program showing how to set up the meter and display readings on a PC screen is provided in the manual. Examples for both QBasic and Turbo C are included.

An optional GPIB interface is also available for automated test environments. Remote control of the meter over the GPIB bus is described in detail in the operation manual.

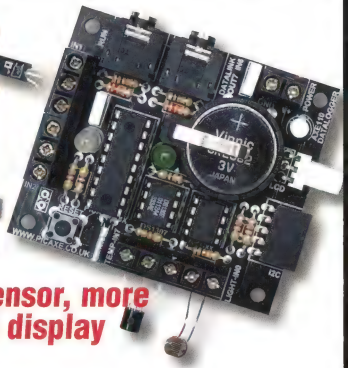
At time of writing, we'd not had the opportunity to thoroughly test all the features of our 3146A review unit. So far, though, it's done everything that we've asked without a hitch. It's easy to use, the big blue display is a real treat, and it sure beats our top-of-the-line hand-held meter in the accuracy stakes. And it costs about the same!

Where to get yours

Escort instruments are available in Australia from NewTek Sales, on the web at **www.newteksales.com** or phone (02) 9888 0100. At time of writing, the Escort 3146A was priced at $990 plus GST, whereas the lower spec 3136A was $600 plus GST. Both models come with a 1-year warranty.

Note that these meters are specified with a 1-year calibration cycle. NewTek can help here too, offering local repair and calibration services out of their North Ryde facility. **SC**

PICAXE-18X 4-channel datalogger



Pt.3: adding a humidity sensor, more memory & a liquid crystal display

In the first two parts of this series, we described how to build and program the PICAXE-18X Datalogger, and showed how to add a battery-backed real-time clock (RTC). In this final instalment, we look at adding a few more goodies, including a humidity sensor, a liquid crystal display and more memory.

By CLIVE SEAGER

There are various humidity sensors on the market but the recommended device for use with the PICAXE-18X Datalogger is the Honeywell HIH-3610-001. This sensor is a direct humidity-to-voltage device with built-in conditioning circuitry.

It is supplied in a small 3-pin single-in-line package. Two of the pins connect to a regulated +5V power source, while the third gives a linear output voltage that's proportional to humidity. This means that it can be connected directly to the Datalogger (via connector CT4) without any additional circuitry (see photo above).

As with all humidity sensors, take care not to physically touch the sensing area of the device, as moisture/oils from the hand could damage the sensitive sensor element.

A sample graph of the response of the humidity sensor is shown in Fig.1.

When used with the PICAXE, the voltage output of the sensor is measured by the internal analog-to-digital converter (ADC) and stored in a variable (eg, b1) as a number between 0 and 255. Each ADC step is 5V/256 = 0.0195V (using a regulated 5V supply).

The graph in Fig.1 shows an offset of approximately 0.8V, which equates to an ADC value of 41 (0.8 / 0.0195). The RH (relative humidity) slope is set at about 0.0306V per %RH, or 1.57 ADC steps per %RH.

The actual %RH can be calculated using the following formula:

%RH = (ADC value - offset)/(slope of graph) = (ADC value - 41)/1.57

However, as the PICAXE programming language cannot handle fractions, the divide by 1.57 is actually performed by first multiplying by 100 then dividing by 157, as follows:

%RH = [(ADC value - 41) x 100]/157

Checking these test values against a calibrated probe using the test program in Fig.2 proved the PICAXE system to be very accurate. However, you may need to "tweak" the offset and slope figures depending on sensor calibration, power supply voltage, temperature, etc. An application note showing how to apply temperature compensation is available from **www.phanderson.com/picaxe/hih3610.htm**

Note: in order to preserve the accuracy of the humidity sensor's readings, the Datalogger must be powered from a well-regulated 5V supply.

Controlling humidity

One of the things I enjoy most about my job is observing the interesting and varied electronics projects turned out by high school students for their electronics course work. Within the UK curriculum, 60% of the final grade is allocated to a practical project and many students produce some wonderful pieces of work.

For example, a school I visited recently had produced a number of PICAXE projects linked to a local wildlife water park. One of their most interesting projects was an incubator for working with eggs from rare breed birds.

Movement, humidity and temperature are the crucial factors when incubating eggs. Movement and temperature are relatively easy to control but commercial humidity controllers are very expensive, and generally involve

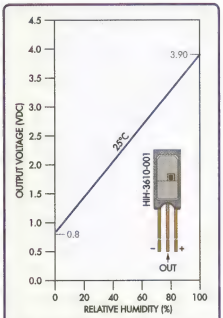
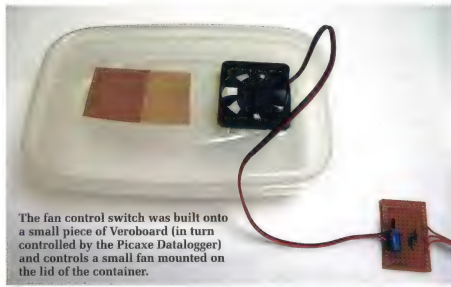


Fig.1: this diagram shows the pin out of the humidity sensor and its response characteristics.



The fan control switch was built onto a small piece of Veroboard (in turn controlled by the Picaxe Datalogger) and controls a small fan mounted on the lid of the container.

Fig.2: Test Program

```
main:
        readadc 1,b1            'read humidity value
        let b1 = b1 - 41 * 100 / 157    'change to %RH
        debug b1                'display on screen
        pause 500               'wait 0.5 second
        goto main               'loop
```

some form of pump which releases water onto a sponge. The surface area of this sponge is crucial and may often need physical adjustment.

The disadvantage of this system is that the response time is extremely slow and so the humidity can fluctuate wildly. It is also not very hygienic as the sponge rapidly attracts bacteria. Therefore, the students had devised a very novel and low-cost alternative.

Their humidity unit is based around a plastic food container filled with water. Two holes are cut in the lid of the box. One hole provides an opening for a small 5V fan, which is attached to the box with hot-melt glue. The second hole (measuring about 20mm x 50mm) is covered with a piece of plastic, which is "hinged" along one edge with adhesive tape to form a "flap".

When the fan is switched on, air pressure lifts the plastic flap, allowing moisture-laden air from the fan's draft to escape from the box. When the fan is switched off, the plastic flap falls and effectively seals the box (in practice, the small surface area exposed through the fan blades makes little difference to the operation of the system).

This system provides a very large effective surface area when the fan is running, which means that the humidity can be much more accurately controlled. In fact, it works so well that the wildlife park managed to hatch exotic eggs in the students' incubator that had never before hatched in the commercial units!

The Datalogger controls the fan with the aid of a simple interface circuit (Fig.3). The circuit can be constructed on a small strip of Veroboard (or similar) and wired to the Datalogger's piezo sounder output (Output 0).

Serial LCD add-on

The students had also used a serial LCD module within the incubator to display the temperature and humidity readings. The LCD module consists of a conventional 16-character, 2-line LCD "piggy-backed" onto a microcontroller-based PC board. The microcontroller's task is to receive serial data from the Datalogger and generate the signals necessary to display the data on the LCD.

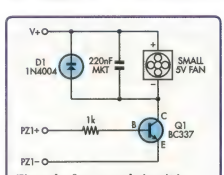


Fig.3: the fan control circuit is connected to the unused piezo output terminals on the Datalogger.

Only three wires are required to connect a serial LCD to the Datalogger. The V+, 0V and Data pins on the Datalogger's LCD connector (CT9) go to the corresponding pins on the serial LCD.

Note that the LCD module includes a polarity protection diode in series with the V+ input. The 0.7V drop across this diode causes a reduction in LCD contrast ("brightness") when operating from a 4.5V battery supply. If you experience this problem, replace the diode with a wire link – but make sure that you have the supply leads around the right way first!

Note: the serial LCD module described here is an optional add-on that can be purchased as a kit of parts. Complete assembly instructions are included with the kit.

The program to regulate and display the humidity is shown in Fig.4 (target value 60% RH). This program also displays the temperature to three decimal places. The temperature and light values are read every five seconds and displayed on the serial LCD via

Fig.4: Humidity Program

```
SYMBOL temperature = w0
SYMBOL temperatureLSB = b0
SYMBOL temperatureMSB = b1
SYMBOL humidity = w1
SYMBOL scratchpad = w2
SYMBOL address = w3
SYMBOL counter = w4

main:
        for counter = 1 to 12     '12 * 5 seconds = 1 minute
'
'Read and correct RH value
'
do_RH:
        readadc 1,humidity
        let humidity = humidity - 41 * 100 / 157
'
'Switch fan on or off as necessary
'
control_fan:
        if humidity < 60 then fan_on

fan_off:
        low 0                     'switch fan on
        goto do_temp
fan_on:
        high 0                    'switch fan off
'
'Read raw 12 bit data from DS18B20 temperature sensor
'
do_temp:
        readtemp12 7,temperature
'
'Format data into two bytes:
'temperatureMSB = value before decimal place
'temperatureLSB = value after decimal place
'
        temperatureMSB = temperature / 16
        scratchpad = temperatureLSB & $0F * 625 / 10
        temperature = scratchpad
'
'Display humidity and temperature on serial LCD
'
do_display:
        serout 6,N2400,(254,128,"RH% = ", #humidity)
        serout 6,N2400,(254,192,"Temp = ", #temperatureMSB, ".")
        if temperatureLSB > 100 then skip0
        serout 6,N2400,("0")              'display leading 0 if required
skip0:
        serout 6,N2400,(#temperatureLSB)
        pause 5000                        'wait 5 seconds
        next counter                      'next loop
'
'1 minute is up so log temperature and humidity
'
log_data:
        high 3                                          'LED green
        low 5                                           'write enable

        i2cslave %10100010, i2cfast, i2cword            'select EEPROM 1
        writei2c address,(humidity)                     'write the value
        pause 10                                        'wait write time

        i2cslave %10100100, i2cfast, i2cword            'select EEPROM 2
        writei2c address,(temperatureLSB)               'write the value
        pause 10                                        'wait write time

        i2cslave %10100110, i2cfast, i2cword            'select EEPROM 3
        writei2c address,(temperatureMSB)               'write the value
        pause 10                                        'wait write time

        high 5                                          'write protect
        low 3                                           'LED off

        let address = address + 1                       'increment address
        if address < 32767 then main                    'if memory not full
        end
```

Where To Get The Parts

The complete Datalogger kit (Part No. AXE110), memory expansion kit (Part No. AXE111) and serial LCD kit (Part No. AXE033) are available from Microzed and their distributors. Contact Microzed on (02) 6772 2777 or check out their web site at **www.microzed.com.au**.

The Honeywell HIH-3610-001 humidity sensor is available from Farnell, Cat. 393-7446. Check out their on-line catalog at **www.farnellinone.com.au** or phone 1300 361 005.

the **serout** command. The values are also logged in EEPROM once every minute (see last months article for more details).

The **serout** command codes "254,128" and "254,192" in the program listing are "cursor" commands that move the cursor to the top and bottom lines of the LCD, respectively.

Temperature measurements

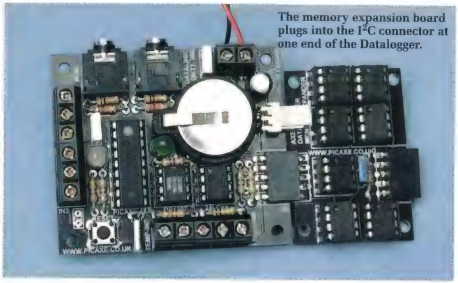
The DS18B20 temperature sensor (supplied with the Datalogger kit) is a 12-bit digital device with a maximum resolution of 0.0625°C. Much of this accuracy is lost with the PICAXE **readtemp** command, which automatically rounds and corrects the value to the nearest whole degree.

However, the PICAXE-18X part also has a **readtemp12** command, allowing all 12 bits of the temperature reading to be retained for maximum accuracy. The program in Fig.4 shows how to separate the raw 12-bit data into two bytes – the "whole degree" and the "fraction" after the decimal place. These values are then displayed to three decimal places on the LCD.

Expanding the memory.

The Datalogger kit is supplied with a single 24LC16B EEPROM. This provides enough space for 512 byte-sized readings for four sensors, or 1024 readings for two sensors. For some experiments, you may want to add more memory and with the PICAXE-18X Datalogger, this is very easy to do!

The simplest upgrade involves replacing the 24LC16B EEPROM with the larger, pin-compatible 24LC256



The memory expansion board plugs into the I²C connector at one end of the Datalogger.

device. This increases the available space to 8192 byte-sized readings for four sensors.

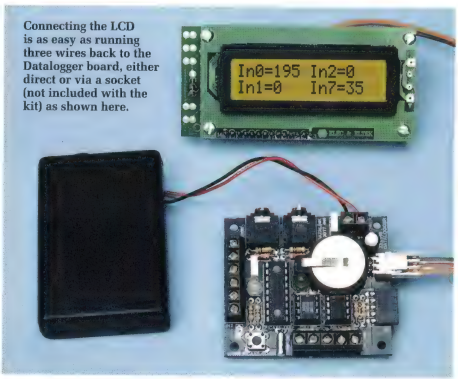
In programming terms, the only real difference between the two chips is the **i2cslave** command used. For the 24LC256, use the **i2cslave, %10100000, i2cword** command as it has a word address rather than a byte address.

If desired, up to seven more 24LC256 EEPROMs can be added to the datalogger with the addition of a memory expansion board. This multiplies the available memory by eight times! The memory expansion board is a small PC board with seven sockets to accept the additional EEPROMs. It simply plugs into the Datalogger via the 5-pin I²C expansion connector (CT8).

The program shown in Fig.4 stores data in the 24LC256 EEPROMs in positions 1, 2 and 3 on the expansion board. Up to 32,768 readings can therefore be made, giving over 22 days of logging with the 1-minute sampling interval shown. **SC**

About the Author

Clive Seager is the Technical Director of Revolution Education Ltd, the developers of the PICAXE system.



Connecting the LCD is as easy as running three wires back to the Datalogger board, either direct or via a socket (not included with the kit) as shown here.

Want really bright LEDs?

We have the best value, brightest LEDs available in Australia! Check these out:

Luxeon 1 and 5 watt LEDs
All colours available, with or without attached optics, as low as $10 each

Lumileds Superflux LEDs
These are 7.6mm square and can be driven at up to 50mA continuously.
- Red and amber: $2 each
- Blue, green and cyan: $3 each

Asian Superflux LEDs
Same size and current as the Lumileds units, almost the same light output, but a fraction of the price.
- Red and amber: Just 50 cents each!
- Blue, green, aqua and white: $1 each.

Go to www.ata.org.au and check out our webshop or call us on (03)9388 9311.

Silicon Chip Binders

★ Each binder holds up to 12 issues

★ SILICON CHIP logo printed on spine & cover

Price: $A12.95 plus $A5 p&p each. Buy five and get them postage free (available only in Australia).

Just fill in the handy order form in this issue; or fax (02) 9979 6503; or ring (02) 9979 5644 & quote your credit card number.

By RODNEY CHAMPNESS, VK3UG

The little 1934 Astor Mickey

From the 1920s onwards, Astor produced many fine receivers, the Astor Mickey being one of their early mantel receivers. It was a very compact 5-valve receiver and the "OZ" model number that was used to denote the Australian model now seems quite relevant.

It's probably just coincidence that Astor used "OZ" to denote the Australian version of this receiver. The term "OZ" didn't become slang for Australia until much later on, so it's impossible to say just why the "OZ" model number was used.

The Astor Mickey "OZ" was a modified version of an American receiver that was designed to run off 110V mains. In the US, Radio Corporation must have thought that they had it made with the "Mickey Mouse" name, since it reminded people of the Walt Disney character of the same name. However, the people at Walt Disney were not amused and legal action eventually resulted in the name being altered to just plain "Mickey".

The Astor Mickey model OZ was built into an attractive walnut cabinet. Note the very small elementary dial scale. It consists of a reduction drive and uses a gramophone pick-up needle(!) as the dial pointer.

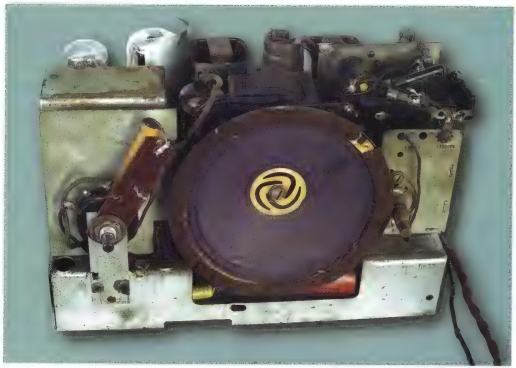
US designs

Quite a few of the receivers sold in Australia during the 1920s and 1930s were close copies of American sets of the era, often being built under a licence agreement. Australia's manufacturing base for radio receivers was not as advanced as America's at that time and so the use of American designs made good business sense for manufacturers looking to steal a march on their rivals.

The Astor Mickey "OZ" was quite a compact receiver for its time, despite the fact that it included a power transformer, a couple of intermediate frequency (IF) transformers, a tuning gang, various coils, a loudspeaker, an output transformer, miscellaneous passive components and, last but not least, five large valves. In fact, Astor did a marvellous job of shoe-horning them all into such a small space.

A side effect of this "shoe-horning" was that the audio output and rectifier valves cause other components in their near vicinity to get quite hot as well. For example, the tops of the valve envelopes are quite close to the top of the cabinet and this inevitably became heat-damaged. To minimise this, vertical ventilation slots were cut into the lefthand end of the cabinet to assist airflow, while a sheet of asbestos(!) was fitted above the valves to reduce heat transfer to the cabinet.

Most of these sets will still have the asbestos fitted, so be careful if you are working on one of these receivers. Asbestos is a carcinogen and should be treated with great caution. To prevent fibres of asbestos coming off the sheet, it could perhaps be sprayed with clear Estapol which should seal



This front view shows the chassis after it has been removed from the cabinet. Notice how closely the components have been packed together. There's no wasted space here!

Below: a rear view of Astor OZ. This shows the very compact nature of the set, considering that it uses full-sized components. Be aware that a sheet of asbestos is used above the two valves at the right of the photograph.

its surface and thus prevent any loss of material. How you deal with it is up to your own good commonsense. I'm certainly not an expert on dealing with asbestos safely.

Front-panel controls

The front panel of the receiver carries the volume and tuning controls, with the volume control to the left and the tuning to the right. A brass plate behind each knob identifies its function and these plates are attached to the wooden cabinet via escutcheon pins. The loudspeaker is fitted behind a fret in the front of the cabinet, which is covered with speaker cloth.

The tuning control is similar to that used in many other early sets and features a small circular dial-scale that's located behind the knob – in fact, it's hardly worth calling a "dial scale". There is a reduction drive to the gang and the pointer for the tuning consists of a gramophone pick-up needle that's inserted into the reduction drive brass ring. There are no frequency calibrations or station callsigns on the dial scale – just a 0-100 scale.

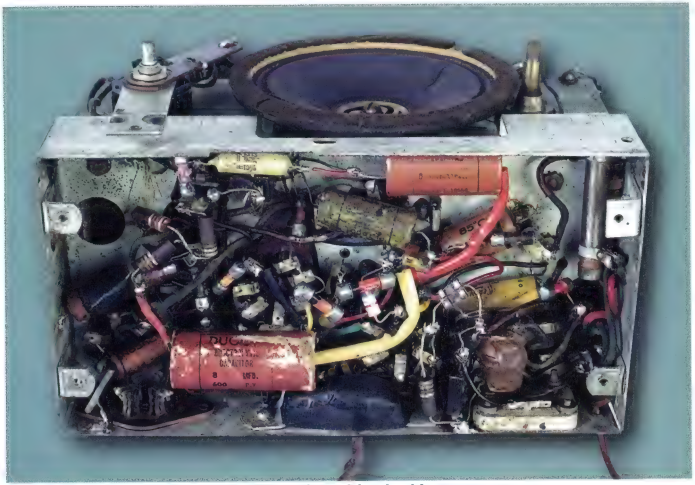
There were certainly some big improvements made to dial-scales in the years following 1934, when this set was manufactured.

Removing the chassis

The set is reasonably easy to dismantle. First, the knobs are unscrewed and the brass dial-scale is levered off. That done, four bolts are removed from the base of the cabinet, after which the chassis is can be slid out of the case. This has to be done carefully, as it is a tight fit.

With the chassis exposed, it quickly becomes clear that there is a lot of radio packed into a small space! There is very little space between the chassis-mounted items and you need nimble fingers to remove the detector-cum-first-audio valve. That said, I've seen more awkward layouts than this. However, it is just as well that tuning capacitors are usually trouble free, as the gang is completely covered by the oscillator and antenna coils and their associated components.

The view underneath the chassis is a bit more frightening, with a mass of components and various leads going



The under-chassis view of the Astor Mickey OZ reveals a real dog's breakfast, with a mass of components and leads going everywhere! It is a difficult receiver to service because the components are so crowded together.

all over the place. This particular set had been serviced on several occasions in the past and this has only added to the confusion with the layout. Replacement components appear to have been tacked in wherever possible and, over the years, a significant number of the capacitors and resistors have been replaced. However, they were not all replaced at the same time, as components from several eras are evident.

Circuit details

Redrawing the circuit diagram of this radio using circuit symbols from the end of the valve era would quickly disguise the fact that it was designed in 1933. In fact, if the valve type numbers were unknown and if the field coil on the speaker is ignored, this circuit could easily be mistaken for one of many dozens produced during the 1960s. Even by the mid-1930s, the superhet receiver had been almost fully developed.

Of course, there are differences between this set and later sets but these are purely refinements of what had already been produced. For example, the quality of the coils improved with the advent of iron dust and ferrite cores, as well as then being able to make them much smaller. In addition, the valves became much smaller with the introduction of 7-pin and 9-pin units, but their characteristics remained similar to the octal and pre-octal valves that they replaced.

For example, the 6D6 (in this set) later became the 6U7G, which has almost the same characteristics as the later miniature 6BH5.

Another difference is that electrodynamic loudspeakers gave way to permanent magnet units, which saved power because they didn't require a field coil to produce a magnetic field. And over the years, the electrolytic and paper capacitors gradually became smaller for the same capacitance, with the unreliable paper types ultimately replaced by polyester capacitors.

Finally, towards the end of the valve era, thermionic power rectifiers were replaced by more efficient silicon power diodes. So while there were significant improvements in the components used, the circuit designs of common domestic radio receivers remained much the same.

Australian modifications

This receiver was, as mentioned earlier, an "Australianised" version of an American radio. The American design was for a transformerless set which ran directly off the 110V mains. In this design, the valve heaters would have all been connected in series, which meant that 69V was needed across them for best performance (possibly achieved by using a dropping resistor).

As a result, the circuitry of the receiver were designed to operate efficiently off 110-140V DC. At this voltage, the 43 output stage gives quite reasonable audio output.

Modifying the set for Australia involved adding a mains transformer to supply the voltages required. This transformer allowed the set to be used with the Australian 240V mains and featured three heater windings to cater for the various heater voltages. In ad-

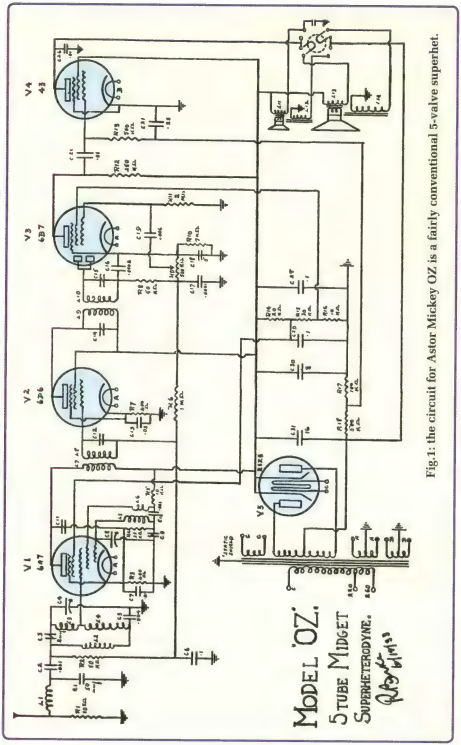


Fig.1: the circuit for Astor Mickey OZ is a fairly conventional 5-valve superhet.

dition, the rectifier circuit was modified to function as a full-wave unit, instead of the half-wave unit used in the original design.

However, some later versions of this radio used valve heaters that were wired in series and a half-wave rectifier was used to supply the HT voltage for the set. These later receivers were very much an American design, with a power transformer "hung" on the mains to give the right voltages. As before, it was no longer necessary to use a dropping resistor to reduce the 110V to 69V as the heater winding on the transformer provided just the right voltage.

The power transformer probably fitted in the space vacated by the heater dropping resistor in the American sets. And as well as providing the correct voltages, it certainly makes the set

VALVES
AUDIO HI-FI
AMATEUR RADIO
GUITAR AMPS
INDUSTRIAL
VINTAGE RADIO
We can supply your valve needs, including high voltage capacitors, Hammond transformers, chassis, sockets and valve books.
WE BUY, SELL and TRADE
SSAE DL size for CATALOGUE
ELECTRONIC VALVE & TUBE COMPANY
PO Box 487 Drysdale, Vic 3222
76 Bluff Rd, St Leonards, 3223
Tel: (03) 5257 2297; Fax: (03) 5257 1773
Email: evatco@pacific.net.au
www.evatco.com.au

MEASURE RF VOLTAGES IN CIRCUIT
• 100kHz - 750MHz @ 10mV sens. (usable to 1.5GHz)
• Up to 70V RMS (100Vpk)
• Use with any standard DMM
• High tensile tip
Why spend $$$$ on a UHF CRO?
RFP5A01M
Designed & Made in Australia
RF Probes Pty Ltd
PO Box 6, Greensborough 3088
Phone:(03) 94321936 Fax:(03) 9444 7750
Email: admin@rfprobes.com.au
www.rfprobes.com.au

KALEX
• High Speed PCB Drills • PCB Guillotine
Laser Labels • PCB Material – Negative or Positive Acting • Light Boxes – Single or Double Sided; Large or Small • Etching Tanks – Bubble • Electronic Components and Equipment for TAFEs, Colleges and Schools • Prompt Delivery
We now stock Hawera Carbide Tool Bits
716 High Street Rd, Glen Waverley 3150
Ph (03) 9802 0788 FAX (03) 9802 0700
Website: www.users.bigpond.net.au/kalex
Email: kalexpcb@bigpond.net.au
ALL MAJOR CREDIT CARDS ACCEPTED

This top rear view of the chassis again shows how close the major components (valves, IF transformers, etc) are together. Note the side adjustments on the air-cored IF transformers at the rear of the chassis

safer to work on. Indeed, Australians have always had a dislike of live chassis equipment, in contrast to the Europeans and Americans.

Circuit details

As mentioned earlier, the circuit layout is quite standard, although the tuned input circuit does require some comment. This tuned circuit consists of L3, L4, C4 and C5, with tuning capacitor C4 being adjusted to tune to the desired station. In addition, these components, together with the remainder of the parts in the input circuit, form a complex network that's designed to have a broad response across the broadcast band but with the response dropping off rapidly outside this band.

The reason for this is that the designers were concerned about breakthrough from marine Morse code stations in the 400-513kHz frequency range into the intermediate frequency (IF) amplifier. That said, it probably would have been simpler to have put an IF trap in the antenna circuit on 456kHz. However, this is one of the earlier sets using a 456kHz (455kHz) IF amplifier stage and, because it uses air-cored low-Q transformers, the frequency response was probably sufficiently broad to allow signals well away from 456kHz to get through.

The antenna circuit used in the Astor Mickey was obviously designed to overcome this problem by rapidly attenuating signals outside the broadcast band. Without this circuitry, either an annoying thumping noise or a tone-modulated series of short and long signals would have been evident to the listener. Indeed, one of my receivers from the 1960s was prone to this problem.

Of course, this is no longer an issue, as the marine medium frequency (MF) stations closed down at the turn of the century.

The IF amplifier is quite conventional and uses trimmers to tune each IF transformer winding. The adjustments are made from the side of each transformer and as can be seen in photograph, they can be adjusted with the set in the cabinet.

The IF stage is followed by a diode detector cum-AGC-diode stage, followed in turn by a pentode first audio stage and a pentode audio output stage. Provision is made for an extension speaker, as shown in the lower right of the circuit diagram.

All stages use cathode bias except for the audio output stage, which uses back bias. The field coil is in the negative lead of the power supply and 1/6th of the voltage across this is applied as the back bias.

The power supply is conventional and uses a mains transformer and full-wave rectifier (V5) to produce the high-tension (HT) voltage (135V). Lower voltages for various sections of the receiver are obtained from a voltage divider network across the HT rail, consisting of resistors R14, R15 & R16.

Alignment

The alignment of the IF stage is conventional and involves applying a modulated signal from a signal generator (set to the IF frequency) to the grid of the 6A7 RF stage. The audio output level at the speaker (or the DC voltage across the volume control) is then measured and the tuning peaked for a maximum reading.

The alignment of the antenna and oscillator circuits is also conventional. The set nominally tunes 550-1500kHz but by carefully adjusting the two trimmers on the tuning gang at the high-frequency end of the band and the padder capacitor (C9) at the low-frequency end, the set can be made to tune the entire broadcast band as it is today.

The padder capacitor (C9) is accessed through the back of the chassis, near the aerial and earth terminals. However, it really is guess work as to where the alignment points of 600kHz and 1400kHz should appear on the dial, as it is only calibrated 0-100!

The procedure for tuning the front end is fully explained in "Vintage Radio" for February 2003. On a cautionary note, don't adjust C3 unless you really know what you are doing. This small capacitor (about 2pF) consists of two short lengths of insulated wire twisted together and forms part of the broadcast bandpass image and IF rejection circuit.

Performance

It's a bit hard to judge just how well this set performs, since it has yet to be restored. However, it's doubtful that it will be up to the standards of

Photo Gallery: Philips Model 6506 – Medium Wave (1937)

With its vertical edge beading, chrome-plated grille bands and chrome-plated station pointer, the Philips Model 6505 is a classic example of art deco styling. The set came with either "E" series or "A" series valves, the former with 6.3V heaters and a 4V rectifier, the latter with 4V heaters and a 6.3V rectifier. Tuning was accomplished using a large disc and wedge wheel, with an anti-backlash mechanism. (Set restored by Maxwell L. Johnson; photo by Ross Johnson).

comparable receivers from the 1950s and 1960s, due to the low Q of many of the coils.

The cabinet

The cabinet is quite small for the era, being just 305mm long, by 180mm high and 140mm deep. It is, however, quite attractive and is made from walnut ply, with the front made from a piece of figured walnut. Black paint highlights the controls, the speaker grille and the base of the cabinet.

As shown in one of the photos, the cabinet style is different in that the top is curved down in the centre – almost like a small seat! It does look quite effective and this set would have looked every bit as good as many other high-quality sets of the era.

The cabinet has been restored using flat clear polyurethane and looks quite impressive. However, a little later on, its owner intends to finish the cabinet restoration with a mixture of 60% gloss nitro-cellulose lacquer. The interior will be given a coat of matt black paint to finish it off.

Summary

Despite being a 1933 design, the circuit of the Astor Mickey is similar to many radios that appeared towards the end of the valve era. It only suffers in performance compared to these later sets because of the inferior components that were available in 1933-4.

Astor managed to cram a lot into a cabinet that is similar in size to most mantel sets of the later valve era. Considering this, access to the works is quite reasonable. The cabinet is of an eye-catching design and even today the set would look good and sound good in the home.

It's no wonder that these receivers command high prices when sold. If you have the opportunity of obtaining one at a reasonable price, then "go for it". SC

Silicon Chip Binders

These binders will protect your copies of SILICON CHIP. They feature heavy-board covers & are made from a distinctive 2-tone green vinyl. They hold up to 14 issues & will look great on your bookshelf.

★ 80mm internal width

★ SILICON CHIP logo printed in gold-coloured lettering on spine & cover

★ Buy five and get them postage free!

Price: $A12.95 plus $A5.50 p&p. Available only in Australia.

Silicon Chip Publications
PO Box 139
Collaroy Beach 2097

Or fax (02) 9979 6503; or ring (02) 9979 5644 & quote your credit card number.

Use this handy form

Enclosed is my cheque/money order for

$_____ or please debit my

❑ Bankcard ❑ Visa ❑ Mastercard

Card No:

_____

Card Expiry Date ____/____

Signature _____

Name _____

Address _____

_____ P/code_____

ASK SILICON CHIP

Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Write to: Ask Silicon Chip, PO Box 139, Collaroy Beach, NSW 2097; or send an email to silchip@siliconchip.com.au

Poor damping factor for Studio 350

I have always considered Damping Factor to be of the utmost importance in the design of the highest quality audio amplifiers. I was interested to see the new 350W amplifier module but incredibly disappointed to see a D.F. of only 75. Any reasons? (C. A., Wagga Wagga, NSW).

● The reason is due to the InDesign desktop publishing software we use. Unless special precautions are taken when the text is "tagged" for style prior to importing, it can ignore text beginning with the ">" symbol (greater than). The specification should have read ">180 @ 100Hz & 1kHz; >75 at 10kHz, with respect to 8 ohms". So the damping factor is actually pretty good.

Setting a trap for a plant thief

A person who I know has been stealing plants from my backyard and taking them to his house, replanting them and passing them off as his. What I wanted to do is to record him taking them and pass the information on to the police. He has taken over 20 plants and it is very annoying and costly.

I have a mini spy camera and a VCR. The only problem is that I can't leave the VCR recording 24 hours a day. Do you have some kind of motion detector that would allow my VCR to record only when there was movement? (R. M., via email).

● Have a look at the video security project in the September 1997 issue. This used a PIR (passive infrared sensor) to control starting and stopping of the VCR. However, you might want to consider merely using a PIR sensor to control some strategically placed spotlights.

Bridging the SC480 amplifier modules

I've built a stereo pair of SC480 amplifiers and a friend wants me to build a couple for microphone use, using the balanced microphone preamp you published in the April 1995 edition.

What I need to know is whether the SC480 amplifier is suitable for bridging. I know nothing about bridging other than the fact that Altronics sell an amplifier bridging adaptor kit – would it suit?

I have on hand a couple of 25W amplifier modules published in the December 1993 edition – are these suitable for bridging? (J. H., Falmouth, Tas).

● The SC480s can be bridged using the Altronics bridging kit but you can then only drive an 8-ohm loudspeaker. The 25W amplifier modules are not worth bridging – they don't have enough power output.

Valve preamp as headphone driver

I was just wondering if I could turn the hifi version of the valve preamp (February 2004) into a headphone amplifier? If so, what is required to be done? (R. D., via email).

● Trying to use the valve preamp as a headphone driver is just not practical because the 68kΩ plate load resistor of the second stage severely limits the current that can be delivered.

How to measure damping factor

I have been attempting to work out how one simply measures an amplifier's damping factor, so that I can optimise the design of loudspeakers. Quoting Vance Dickason, in his book entitled The Loudspeaker Design Cookbook, "Amplifier resistance (Rg) is one of the series resistances taken into account when calculating driver Qt. The easiest method is to use the manufacturer's advertised damping factor (D), usually measured at 1kHz: Rg = Rd/(D-1) where Rd is the rated driver impedance".

The problem is that the damping factor can be substantially different at different frequencies and at different drive levels. When designing a loudspeaker it is necessary to measure damping at a more relevant frequency and output level, such as 50Hz and

Zap Protection For Jump Starting

I have been told that if I am jump-starting a car with a flat battery, then I must use jumper leads with "anti-zap" protection to connect to the vehicle with a charged battery.

I appreciate that the vehicle's electronics must be protected from voltage surges but I cannot understand how a 12V battery can give out any more than a nominal 12V. Could you please explain (a) where these high voltages come from; and (b) whether I can retrofit my existing jumper leads with whatever it takes to neutralise these nasty voltages. (M. H., via email).

● Jumper leads with anti-zap protection don't always work. You would be advised to closely follow the instructions in your owner's manual for jump starting. These should minimise any risk to your car's electronics.

Jump starting can certainly cause spikes to be generated. The starter motor itself is a large inductive load and its solenoid and commutator can generate considerable hash and spikes. The problem is made worse by the car's flat battery – because it is flat, it has a higher internal impedance than normal and so it is less able to suppress spikes across the supply.

high power output, such as is experienced by the woofer for whose Qt I am trying to optimise.

Vance provides a means of measuring an amplifier's damping factor but I consistently end up obtaining a result with a negative value!

I also noticed that you have measured the damping factor for the new Studio 350 amplifier (January 2004) as 75 at 10kHz with respect to 8Ω. This figure appears completely useless to someone who would wish to drive say a subwoofer with a cut-off frequency of 50Hz.

Can you please provide the damping factor at 50Hz for the Studio 350 and can you please provide a bullet-proof way for me to measure damping factor? (E. W., via email).

● See the above answer for the damping factor specification of the Studio 350. Typically, an amplifier's damping factor will be much the same for frequencies between 20Hz and 1kHz but will taper off above that, partly due to the reducing feedback factor at high frequencies (ie, reduced open loop gain) and the effect of any output coupling filter network.

Damping factor is the ratio of the load impedance to the source (output) impedance of the driving amplifier. You can derive an equation from Ohm's Law (V = IR; R = V/I) whereby the amplifiers' output impedance $Z_O = (V_O - V_L) \times Z_L/V_L$; where V_O is the open circuit output voltage, Z_L is the load impedance and V_L is the load voltage.

To get damping factor, you divide Z_L by Z_O and this simplifies down to $V_L/(V_O - V_L)$. In practice, you take the difference between the load voltage and the open circuit voltage and divide it into the load voltage (driving an 8-ohm dummy load). Typically, the difference between the load voltage and open circuit voltage will only be a few millivolts so you need a high resolution AC millivoltmeter. A 4.5-digit DMM will do the job.

Depending on the feedback connections in your amplifier, it is possible to have an output impedance which is slightly negative (ie, output voltage increases slightly when the load is connected) but the damping factor is still the ratio of the load impedance to the amplifier's output impedance.

Note that you can do the test at any power level up to clipping and the result should be the same. Typically, we do the test with a least 10V of output signal, otherwise the small difference in signal levels becomes hard to measure.

By the way, damping factor measurements should be done right at the amplifier's output terminals, to avoid the effects of connecting cable resistances. Our damping factor measurements for the Studio 350 module were taken right at the speaker terminals on the PC board. Even a short length of connecting wire can affect the result.

Playmaster 30+30 amplifier overheating

I built the Playmaster 30+30 amplifier as described in EA magazine in April 1992. It uses the Philips TDA1514A power amplifier ICs.

There are a couple of problems I'm having with this project. There seems to be very little low end (bass) from this amplifier. You need to have the bass control on maximum for there to be any kind of appreciable amount of bass - and it's still not quite enough.

But the biggest problem is that one of the power supply filter capacitors keeps failing. The 5600µF on the positive rail starts to bulge on the top until it eventually splits and leaks gunk all over the PC board. One tell-tale sign is that one of the power amplifier ICs runs considerably warmer than the other. It seems to be pulling more current than it should be.

I swapped the ICs over, thinking there was an internal fault with the one that was warming up but the fault did not move with the IC. All voltages around both ICs are OK. I'm at my wit's end as to what the problem could be. Some suggestions would be greatly appreciated. (M. O., via email).

● From the symptoms, it seems likely that one of the TDA1514s (the hot one) is oscillating supersonically. This is causing high ripple current on the positive supply which is overloading the positive rail 5600µF capacitor and causing it to fail.

Check that the Zobel network is OK (R30 & C24) and that all capacitors are correctly soldered into circuit. In particular, check C22 (3.3nF) and C20.

Enhancements to wind-up torch

I have just received the February 2004 issue and intend to build the torch described in it. I intend to add an on/off switch and a small solar cell to charge up a large capacitor, as well as having the stepper motor. Do you envisage any problem with doing this?

Are the capacitors out of dead microwave ovens usable? Taking due care of the dangers initially involved of course! (P. R., via email).

● There is a problem with charging the battery with a solar panel. This is bound to charge the battery to far more than the forward voltage of the LED and so when you switch the torch on, it will initially give excessive voltage to the LED. It may also exceed the voltage rating of the supercaps if these are used as well.

Capacitors in microwave ovens can generally be re-used but be very careful to make sure that everything is discharged before you attempt any circuit disassembly. These capacitors can retain a lethal charge for months after use, especially if their discharge resistors have gone open circuit.

PIC programmer damage

I recently put together the PIC Programmer from the September 2003 issue. As far as I can see, it works fine but I've somehow managed to destroy (I think) a number of PICs (PIC16F628a). I can't imagine that it is my circuit that is destroying it (it is currently only a couple of LEDs attached to the I/O ports via a 1kΩ resistor on each). All of the tests suggested in the article were passed OK.

Is it possible that inserting the PIC with the programmer board switched on could be causing this problem? This seems to be the case but I can't verify this as I don't want to waste any more PICs.

The programmer works as expected for a number of reprogrammings until I get a message "unable to verify pic

PIC programmer problems

I'm having a problem with the PIC Programmer described in September 2003. I built the circuit on my own PC board as I used a simpler (standard 7805-based) power supply to avoid sourcing the LP2951. The programming voltage is fine, until the PIC is inserted, when the pin 4 voltage drops down. Any ideas? (L. W., via email).

● We assume that you haven't modified the Vpp generation circuitry and that you're programming an "F" (flash memory) series micro. As mentioned in the article (under the "Vpp Check" heading), you can use the "Enable MCLR" box in the "Hardware Check" dialog to switch Q7 on and off and examine the operation of this particular part of the circuit.

There should be about +13.6V on the cathode of ZD1 in either condition. If not, check the voltage on the cathode of D4. It should be about +17.8V. The MAX232, D3 & D4, as well as the associated 1µF capacitors, generate the required high voltage. Anything more than a few mA load on this supply will overload it, causing the voltage to drop down.

If all is working properly, only about 0.5mA will be drawn from the high voltage supply, determined by the 1.2kΩ resistor between the base and emitter of Q3 (Q3 & Q4 act as a constant current source for ZD1 & D5). In operation, the voltage drop across this resistor should measure about 0.6V.

The problem is most likely around Q3 to Q7, ZD1 & D5. Check that you haven't accidentally exchanged the PN100/PN200s, etc.

while programming". The PIC still works but cannot be reprogrammed. Any assistance or ideas would be greatly appreciated. (M. W., via email).

● It is possible for PICs to be damaged if they're plugged into a powered programming socket, despite the on-board current-limiting circuit. However, it seems unlikely that this is the cause in your case, as devices damaged in this way will generally fail to function in-circuit.

The devices may have the 'LVP' (Low-Voltage Programming) or 'CP' (Code Protect) fuse bits set. Check that both of these fuses are disabled (not ticked) before hitting the program button.

Also, check the resistance between pin 10 of the programming socket and ground (0V). The 4.7kΩ pull-down resistor on this pin ensures that LVP mode is disabled (regardless of the fuse state) when entering programming mode.

Missing capacitor in balanced input

I have an enquiry regarding the Balanced Input/Output Stages for the Studio Series Equaliser, as featured in the December 1989 issue. I noticed that the circuit diagram on page 75 of that issue does not show the 10µF capacitor from pin 7 of the LM833 to the "Output to Equaliser Input" but it is shown on the PC board layout on page 77 of the same issue. It also looks like it is also present in the accompanying photo on page 74.

I have checked through many of my 1990 back issues and have not been able to find Notes & Errata on this aspect. Could you look into this please and let me know? (W. R., Townsville, Qld).

● The 10µF capacitor at IC1b's output should have been shown on the circuit. It is probably best to use a bipolar or non-polarised capacitor instead of the polarised part mentioned on the overlay diagram.

Cybug solar fly does not respond

I'm having trouble with the Cybug Solar Fly, described in the September 2000 issue of SILICON CHIP. Everything except the insulation tape and the heavier tinned copper wire to stabilise it have been soldered onto the PC board but it won't work. I've tried it outside directly under the sun in 30°C weather and it won't work. I've checked that all the polarities are correct three times and have found no error.

The PC board melted slightly while soldering and I was wondering if you could help me find what the error would be? (C. B. via email).

● You need to do some basic circuit checks. For example, try covering D1 or D2. Does that cause the associated comparator input to go low? If so, what happens at the comparator outputs? Can you turn on the motors by shorting out the respective Darlington transistors?

By this process, you should be able to find what's wrong. Our tip is a missed solder joint or a component soldered in the wrong way.

4-station telephone intercom

I need to build an intercom using normal Telstra type phones with up to four stations. Have you ever published a project that could do this? (J. A., via email).

● We published the 10-station Interphone in August, September and November 1992. You can obtain the PC boards from RCS Radio (Phone 02 9738 0330). Or there is a much simpler PICAXE phone intercom published in June 1992 (no PC board). We can supply these issues for $8.80 each, including postage.

Remote volume control works in one direction

I have just completed assembly of the PIC-controlled remote volume control described in the June 2002 issue of SILICON CHIP. I am using it with the Jaycar AR1073 remote.

The unit does not work at all in the 'clockwise' (increase volume) direction. That is, it will not 'step' up with the channel button, nor will it rotate with the volume button or return to a preset position with the 'unmute' function. The 'mute' and 'acknowledge' LEDs say that signals from the remote are being received OK.

In the reverse, the unit works quite OK in all modes. I have done all the usual checking of component values, placement, etc and the voltage measurements are OK.

I must be doing something wrong, but for the life of me I can't figure out what. Can you guys help? (B. B., via email).

● Check the placement of transistors Q1, Q2, Q3 and Q4. We suspect that two are incorrectly placed.

Induction loop receiver for headphones

Would you please publish a circuit for a pocket or purse-size hearing assist device, with headphone outlet, to pick up voice signals radiated from deaf-aid loops installed in theatres, airports, etc.

A tone control would benefit people whose hearing impairment is in a defined frequency range. As well, small, modern headphones could be appealing to users. (J. A., Magnetic Island, Qld).

● "Electronics Australia" described just such a project in the October 1995 issue. We can supply a photostat copy for $8.80 including postage.

Power-Up doesn't work with TV

I built your Power-Up module from the July 2003 issue and am pleased with its performance on my computer. It is fabulous for powering all those plugpack peripherals such as modem, scanner, printer and speakers.

Now I want to build another unit to power the audio equipment when I turn on my TV. The problem is that the PowerUp is not sensitive enough to reliably detect the difference in current drain between standby and normal operation of the TV, even with careful adjustment of the sensitivity control.

Is it possible to make the unit more sensitive to smaller current changes? (P. T., via email).

● We suspect that your TV set draws considerable current when in standby and so the current detection circuit is being overloaded.

To fix this, try reducing the value of the 470kΩ resistor at pin 2 of IC1a to say, 100kΩ. At the same time, you will need to increase the value of the 2.2nF capacitor to 10nF, to maintain the same roll-off frequency.

HT supply for valve receiver

I read the article on the 12AX7 valve preamplifier in the November 2003 issue with interest, as many years ago I had built a number of similar circuits for guitar preamplification and general audio applications. The part of the article which really appealed to me though was the method of obtaining the HT via a DC-DC converter.

For some years, I have had a project on the back burner to recondition an old military aircraft receiver of the type commonly available years ago. And as transformers capable of supplying suitable HT voltages at a current of 115-120mA seem to be relics of the past, I have puzzled over ways to provide a solution at an affordable cost.

The article infers that the DC-DC converter in its present form should be capable of supplying about 40mA, dependent on the plugpack. I am wondering what modifications to the published circuit would be necessary to provide an HT of 250-260V at a current of 115mA. I have a number of 12V 40W and 60W transformers which, with the provision of rectifier and filtering components, should be suitable for the 12V DC required. (R. K., via email).

● It turns out that we have been very conservative in the design of the converter and it should provide much more than 40mA. In fact, with the right driver stage, the transformer core is capable to delivering about 100 watts. To get 115mA at 260V, you would need to bypass REG1 and fit Q3 with much better heatsink.

Smaller transformer for Studio 350

I have a question regarding the Studio 350 amplifier that was described in the recent issues (Jan-Feb, 2004) . Can a 50-0-50V 300VA toroidal transformer be used? I don't mind the reduced power output. Could you tell me what it would be on a 300VA transformer instead of the 500VA as stated in the article. (E. Z., via email).

● You can certainly use a 300VA transformer and it will probably be quite adequate when playing normal program material. Naturally, the 4-ohm continuous power output will be reduced though.

Power supply for Jacob's Ladder

I recently built a Jacob's Ladder kit (SILICON CHIP, September 1995) and I was wondering what kind of 12V power supply was required and the current output necessary? (D. S., via email).

● A standard DC power supply will probably not be able to drive the Jacobs Ladder successfully due to the high peak currents required. The supply would need to deliver at least 5A at 12V. This is why we recommend using a 12V battery.

You could use a 12V battery charger (with, say, up to 5A charge) in conjunction with a battery if you did not want the battery to go flat over time. Alternatively, you could use the 12V output of a discarded PC power supply. SC

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely. Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

Advertisers are warned that they are responsible for the content of all advertisements and that they must conform to the Trade Practices Act 1974 or as subsequently amended and to any governmental regulations which are applicable.

SILICON CHIP
www.siliconchip.com.au

YOUR DETAILS

Your Name_____
(PLEASE PRINT)

Organisation (if applicable)_____

Address_____

_____

Postcode_____ **Daytime Phone No. (** **)**_____

Email address (if applicable)_____

Method of Payment:

❑ Cheque/Money Order ❑ Bankcard ❑ Visa Card ❑ Master Card

Card No. | | | | | | | | | | | | | | | | |

Card expiry date | | | |

Signature_____

Order Form/Tax Invoice

Silicon Chip Publications Pty Ltd
ABN 49 003 205 490

PRICE GUIDE: SUBSCRIPTIONS

(Note: all subscription prices include P&P). (Aust. prices include GST)

Please state month to start.

Australia: 1 yr	$A76	2 yrs	$A149
1 yr + binder	$A89.50	2 yrs + 2 binders	$A175
NZ (air): 1 yr	$A85	2 yrs	$A159
Overseas (air): 1 yr	$A129	2 yrs	$A250

PRICE GUIDE: OTHER PRODUCTS

(all prices include GST on Aust. orders)

***SILICON CHIP BACK ISSUES in stock:** 10% discount for 10 or more issues or photocopies. Australia: $A8.80 ea (including p&p). Overseas: $A10 each (including p&p by air).

***ELECTRONICS AUSTRALIA:** project photocopies, limited back issues. 10% discount for 10 or more issues or photocopies. Australia: $A8.80 each (including p&p). Overseas: $A10 ea (including p&p by air).

***BINDERS:** BUY 5 or more and get them postage free. (Available in Aust. only): $A12.95 each plus $5.50 p&p each.

***ELECTRONICS PROJECTS FOR CARS, VOL.2**: Aust. $A14.95; NZ/Asia/Pacific $A18.00 including p&p (air); elsewhere $21.50. (All prices include p&p).

***ELECTRONICS TESTBENCH (limited stock)**: Aust. $A13.20; NZ/Asia/Pacific $A15.95 including p&p (air); elsewhere $18.95. (All prices include p&p).

***BOOKSHOP TITLES:** Please refer to current issue of SILICON CHIP for currently available titles and prices as these may vary from month to month.

SUBSCRIBERS QUALIFY FOR 10% DISCOUNT ON ALL *SILICON CHIP* PRODUCTS*
* except subscriptions/renewals

Qty	Item Description	Item Price	P&P if extra	Total Price
Total			$A	

BUY 10 OR MORE BACK ISSUES & GET A 10% DISCOUNT

TO PLACE YOUR ORDER

Phone (02) 9979 5644
9am-5pm Mon-Fri
Please have your credit card details ready

OR

Fax this form to (02) 9979 6503
with your credit card details
24 hours 7 days a week

OR

Mail this form, with your cheque/money order, to:
Silicon Chip Publications Pty Ltd,
PO Box 139, Collaroy, NSW,
Australia 2097

03-04

MARKET CENTRE

Cash in your surplus gear. Advertise it here in Silicon Chip.

CLASSIFIED ADVERTISING RATES

Advertising rates for this page: Classified ads: $20.00 (incl. GST) for up to 20 words plus 66 cents for each additional word. Display ads: $33.00 (incl. GST) per column centimetre (max. 10cm). Closing date: five weeks prior to month of sale.

To run your classified ad, print it clearly in the space below or on a separate sheet of paper, fill out the form & send it with your cheque or credit card details to: Silicon Chip Classifieds, PO Box 139, Collaroy, NSW 2097. Alternatively, fax the details to (02) 9979 6503 or send an email to **silchip@siliconchip.com.au**

Taxation Invoice ABN 49 003 205 490

Enclosed is my cheque/money order for $_____ or please debit my

❑ Bankcard ❑ Visa Card ❑ Master Card

Card No. | | | | | | | | | | | | | | | | |

Signature_____ Card expiry date____/____

Name _____

Street _____

Suburb/town _____ Postcode_____

Phone:_____ Fax:_____ Email:_____

FOR SALE

UNIVERSAL DEVICE PROGRAMMER: Low cost, high performance, 48-pin, works in DOS or Windows incl. NT/2000. $1364. Universal EPROM programmer $467.50. Also adaptors, (E)EPROM, PIC, 8051 programmers, EPROM simulator and eraser.

Dunfield C Compilers: Everything you need to develop C and ASM software for 68HC08, 6809, 68HC11, 68HC12, 68HC16, 8051/52, 8080/85, 8086, 8096 or AVR: $198 each. Demo disk available.

ImageCraft C Compilers: 32-bit Windows IDE and compiler. For AVR, 68HC08, 68HC11, 68HC12, 68HC16. $385.00

Atmel Flash CPU Programmer: Handles the 89Cx051, 89C5x, 89Sxx in both DIP and PLCC44 and some AVR's, most 8-pin EEPROMS. Includes socket for serial ISP cable. $220, $11 p&p. SOIC adaptors: 20 pin $132.00, 14 pin $126.50, 8 pin $121.00.

Full details on web site. Credit cards accepted.

GRANTRONICS PTY LTD, PO Box 275, Wentworthville 2145. (02) 9896 7150 or http://www.grantronics.com.au

---

PCBs MADE, ONE OR MANY. Any format, hobbyists welcome. Sesame Electronics (02) 9593 1025.
sesame777@optusnet.com.au
http://sesame_elec.tripod.com

OSCILLOSCOPE: TEKTRONIX TDS-1002, 60MHz, digital storage. Less than one year old. Never used. $1500.00 o.n.o. Contact Maurece on (02) 9580 9664.

USB KITS: Stepper Motor Controller, USB PIO Interface, DTMF Transceiver, Thermometer, DDS HF Generator, Compass, 4-Channel Voltmeter, I/O Relay Card. Also available: Digital Oscilloscope, Temperature Loggers, VHF Receivers and USB Active X (and USBDOS.exe file) to control our kits from your application.
www.ar.com.au/~softmark

New New New

Silvertone Mark22-SM
Slimline Mini FM R/C Receiver

- 6 Channels
- 10kHz frequency separation
- Size: 55 x 23 x 20mm
- Weight: 25gm
- Modular Construction

Price: $A129.50 with crystal

Silvertone **Electronics**
PO Box 580, Riverwood, NSW 2210.
Ph/Fax (02) 9533 3517
email: youngbob@silvertone.com.au
Website:www.silvertone.com.au

Need prototype PC boards?

We have the solutions – we print electronics!
Four-day turnaround, less if urgent; Artwork from your own positive or file; Through hole plating; Prompt postal service; 29 years technical experience; Inexpensive; Superb quality.

Printed Electronics, 12A Aristoc Rd, Glen Waverley, Vic 3150.
Phone: 1300 132 251; Fax: (03) 9561 5529
Call Mike Lynch and check us out!
We are the best for low cost, small runs.

SPEAKERBITS

Foam surrounds, voice coils, cones and more
Original parts for Dynaudio, Tannoy and others
Expert speaker repairs – 20 years experience
Australian agents for ortofon products
Trade welcome – email for your user ID
Phone (03) 9682 2487

speakerbits.com.au

TAIG MACHINERY
Micro Mini Lathes and Mills
From $489.00

Stepper motors: 200 oz in $89.00, 330 oz in $110.00
Digital verniers: 150mm $55.00, 200mm $65.00
59 Gilmore Crescent (02) 6281 5660
Garran ACT 2605 0412269707

VIDEO - AUDIO - VGA

distribution amps - splitters
digital standards converters - tbc's
switchers - cables - adaptors
genlockers - scan converters

Come to the specialists... **QUESTRONIX**

See products and download pricelist at www.questronix.com.au
fax (02) 4341 2795 **phone (02) 4343 1970**
email: questav@questronix.com.au

CLS
Cygnus Logic Systems

- Industrial High Speed Automation
- Electronic System Design
- Custom Software Design
- Consultancy
- Troubleshooting
- Project Management

Tel: (02) 9904 3991
Fax: (02) 9904 3993
Mob: 0402 985 574
cygnuslogic@iprimus.com.au

Satellite TV Reception

International satellite TV reception in your home is now affordable. Send for your free info pack containing equipment catalog, satellite lists, etc or call for appointment to view. We can display all satellites from 76.5° to 180°.

AV-COMM P/L, 24/9 Powells Rd, Brookvale, NSW 2100.
Tel: 02 9939 4377 or 9939 4378.
Fax: 9939 4376; www.avcomm.com.au

D.I.Y PCB SUPPLIES
& MADE TO ORDER PCBs
For more details: **www.acetronics.com.au**
Phone (02) 9600 6832
email: **acetronics@acetronics.com.au**

Circuit Ideas Wanted

Do you have a good circuit idea? If so, sketch it out, write a brief description of its operation & send it to us. Provided your idea is workable & original, we'll publish it in Circuit Notebook & you'll make some money. We pay up to $60 for a good circuit so send your idea to:

Silicon Chip Publications,
PO Box 139, Collaroy, NSW 2097.

WEATHER STATIONS: Windspeed & direction, inside temperature, outside temperature & windchill. Records highs & lows with time and date as they occur. Optional rainfall and PC interface. Used by Government Departments, farmers, pilots, and weather enthusiasts. Other models with barometric pressure, humidity, dew point, solar radiation, UV, leaf wetness, etc. Just phone, fax or write for our FREE catalogue and price list. Eco Watch phone: (03) 9761 7040; fax: (03) 9761 7050; Unit 5, 17 Southfork Drive, Kilsyth, Vic. 3137. ABN 63 006 399 480.

S-Video . . . Video . . . Audio . . . VGA distribution amps, splitters, standards converters, tbc's, switchers, cables, etc, & price list: **www.questronix.com.au**

sPlan Windows electronic schematic software and **Sprint Layout** Windows PCB layout software are feature packed but low in price.

Pixel Programmable Controller with 4 analog inputs, 8 digital inputs and 8 relay outputs. Can use a 28A or 28X Picaxe. Programmed in Basic or Flow chart.

Labjack USB Data Acquisition Module features 8 12bit analog inputs, 20 digital I/O, 2 analog outputs and high speed counter. Free software, Labview driver and ActiveX component.

DAS005 Parallel Port Data Acquisition Module features 8 12bit Analog inputs, 4 Digital I/Ps & 4 Digital O/Ps. Free windows software and source code.

Dual Relay Modules suitable for TTL and Open Collector Outputs.

Programmers for Atmel and PIC microcontrollers.

Stepper Motor and Servo Motor controller kits.

Switch Mode and Linear Power Supplies and DC-DC convertors.

Full details and credit card ordering available at: **www.oceancontrols.com.au**

ICOM IC-228A 2-Metre Transceiver $205; Marconi TF 801B/3/S Signal Generator 12MHz to 485MHz $125; AWA CR-6B HF Receiver $65; Advance Signal Generator Type E Model 2 100kHz to 100MHz $55; Tektronix RM529 TV Waveform Monitor $45. (08) 8347 4593.

KITS KITS AND MORE KITS! Check 'em out at **www.oztronics.com**

MEGABRIGHT LEDs! 5mm RGB LEDs $1.25 each. 4-chip (100mA) 8mm

Do You Eat, Breathe and Sleep Technology?

Management & Sales Positions

We are a rapidly growing, Australian-owned international retailer with more than 30 stores in Australia and we have a growing expansion program to open many more, so we need dedicated individuals to join our team to help achieve our goals.
If you are customer focused, have an eye for detail, empathy for the products we sell and have recently completed a TAFE of University degree in electronics, we want to meet you.
Career opportunities with full training are available now if you have the drive and ambition to make your future with Jaycar.
We offer a competitive salary, sales commission and many other benefits. To apply for these positions please send your C.V. indicating the role you are interested in to the address shown below.

Retail Operations Manager
Jaycar Electronics Pty. Ltd.
P.O. Box 6424
Silverwater NSW 1811
Fax: (02) 9741-8500
Email: jobs@jaycar.com.au

Jaycar ELECTRONICS

Jaycar Electronics is an equal opportunity employer and actively promotes staff from within the organisation.

CARBA-TEC TOOLS FOR WOOD

Building speaker boxes? Mounting electrical components onto solid timber? You may need the Carba-tecTOOLS FOR WOOD catalogue!!

We have Australia's largest range of woodworking handtools & machinery. Please contact us for your FREE 220 page colour catalogue or come in & see us at:

32 PERCY ST, AUBURN 2144 9649 5077 www.carbatec.com.au

Printed Circuit Board Manufacture
48-Hour service • High quality • Low prices
1 offs to any quantity
Artwork design if required
Call for obligation free quote...
INSTANT PCBs, POBox 448, Avalon 2107
Ph (02)9974 1189 Fax (02)9974 5491

megabright LEDs from $1.20 each. 5mm superbright white and blue LEDs from 60 cents each. CR123A lithium batteries $4 each. **www.ledsales.com.au**

RCS RADIO/DESIGN is at 41 Arlewis St, Chester Hill 2162, NSW Australia, and has all the published PC boards from SC, EA, ETI, HE & AEM and others. Tel (02) 9738 0330. **sales@rcsradio.com.au,www.rcsradio.com.au**

KIT ASSEMBLY

NEVILLE WALKER KIT ASSEMBLY & REPAIR:

- Australia wide service
- Small production runs
- Specialist "one-off" applications

Phone Neville Walker (07) 3857 2752
Email: **flashdog@optusnet.com.au**

WANTED

EARLY HIFI'S, AMPLIFIERS, Speakers, Turntables, Valves, Books, Quad, Leak, Pye, Lowther, Ortofon, SME, Western Electric, Altec, Marantz, McIntosh, Goodmans, Wharfedale, Tannoy, radio and wireless. Collector/Hobbyist will pay cash. (02) 9440 1267. **johnmurt@highprofile.com.au**

NOW AVAILABLE FROM SILICON CHIP www.siliconchip.com.au

Electronics Australia

Project Reprints – Limited Back Issues –Limited One-Shots

If you're looking for a project from ELECTRONICS AUSTRALIA, you'll find it at SILICON CHIP! We can now offer reprints of all projects which have appeared in Electronics Australia, EAT, Electronics Today, ETI or Radio, TV & Hobbies. First search the EA website indexes for the project you want and then call, fax or email us with the details and your credit card details. Reprint cost is $8.80 per article (ie, 2-part projects cost $17.60). SILICON CHIP subscribers receive a 10% discount.
We also have limited numbers of EA back issues and special publications. Call for details!

visit **www.siliconchip.com.au** or **www.electronicsaustralia.com.au**

Advertising Index

Acetronics 94
Altronics 23
ATA 81
Av-Comm 94
Bitscope 57
Carba-Tec Tools 95
Cygnus Logic Systems 94
Dick Smith Electronics 30-33
Eco Watch 94
Elan Audio 41
Evatco 85
Gadget Central ..... IFC
Grantronics 93
Harbuch Electronics 55
Hy-Q International 57
Instant PCBs 95
Jackson Bros 94
Jaycar 43-54,57,95
JED Microprocessors 5,57
Kalex 85
Microgram Computers 3
MicroZed Computers 21
National Instruments .... loose insert
Newtek Sales 15
Oatley Electronics 65
Ozitronics 41
Prime Electronics 29
Printed Electronics 94
Quest Electronics 55,94
RCS Radio 95
RF Probes 85
Silicon Chip Binders 15,87
Silicon Chip Bookshop 96,IBC
SC Car Projects Book 63,OBC
Silicon Chip Subscriptions 92
SC Electronics Testbench 42
Silvertone Electronics 94
Soundlabs Group 57
Speakerbits 94
Taig Machinery 94
Telelink Communications 57

PC Boards

Printed circuit boards for SILICON CHIP projects are made by:

RCS Radio Pty Ltd. Phone (02) 9738 0330. Fax (02) 9738 0334.

SILICON CHIP REFERENCE

GREAT BOOKS FOR

ALL PRICES INCLUDE GST AND AF

$89

AUDIO POWER AMPLIFIER DESIGN HANDBOOK by Douglas Self 3rd Edition 2002

A handbook for professionals and students from one of the world's most respected audio auth-orities. New edition is more comprehensive than ever with a new chapter on Class G amplifiers and further new material on out-put coils, thermal distortion, relay distortion, ground loops, triple EF output stages and convection cooling. 427 pages in paperback.

$46

PIC Your Personal Introductory Course

by John Morton – 2nd edition 2001

Concise and practical guide to getting up and running with the PIC Microcontroller. Assumes no prior knowledge of microcontrollers, introduces the PIC's capabilities through simple projects. Ideal introduction for students, teachers, tech-nicians and electronics enthusiasts – perfect for schools and colleges. 270 pages in soft cover.

$87

VIDEO SCRAMBLING AND DESCRAMBLING FOR SATELLITE & CABLE TV by Graf & Sheets 2nd Edition

If you've ever wondered how they scramble video on cable and satellite TV, this book tells you! Encoding/decoding systems (analog and digital systems), encryption, even schematics and details of several encoder and decoder circuits for experimentation. Intended for both the hobbyist and the professional. 290 pages in paperback.

AUDIO ELECTRONICS

By John Linsley Hood. First published 1995. Second edition 1999.

For anyone involved in designing, adapting and using analog and digital audio equipment. It covers tape recording, tuners and radio receivers, preamplifiers, voltage amplifiers, audio power amplifiers, compact disc technology and digital audio, test and measurement, loudspeaker crossover systems, power supplies and noise reduction systems. 375 pages in soft cover.

$92

4th EDITION

$70

UNDERSTANDING TELEPHONE ELECTRONICS

By Stephen J. Bigelow. 4th edition 2001

Based mainly on the American telephone system, this book covers conventional telephone fundamentals, including alog and digital communication techniques. Provides sic information on the functions of each telephone component, how dial tones are generated and how digital transmission techniques work. 402 pages, soft cover.

3rd EDITION

$103

EMC FOR PRODUCT DESIGNERS

By Tim Williams. First published 1992. 3rd edition 2001.

Widely regarded as the standard text on EMC, provides all the key information needed to meet the requirements of the EMC Directive. Most importantly, it shows how to incorporate EMC principles into the product design process, avoiding cost and performance penalties, meeting the needs of specific standards and resulting in a better overall product. 360 pages in paperback.

3rd EDITION

$63

GUIDE TO TV & VIDEO TECHNOLOGY

By Eugene Trundle. 3rd Edition 2001

Eugene Trundle has written for many years in Television magazine and his latest book is right up to date on TV and video technology. Includes both theory and practical servicing informationand is ideal for both students and technicians. 382 pages, in paperback.

$89

ANALOG ELECTRONICS

By Ian Hickman. 2nd edition1999.

Essential reading for electronics designers and students alike. It will answer nagging questions about core analog theory and design principles as well as offering practical design ideas. With concise design implementations, with many of the circuits taken from Ian Hickman's magazine articles. 294 pages in soft cover.

$69

TELEPHONE INSTALLATION HANDBOOK

by Steve Roberts. 2nd edition 2001.

Based mainly on British practice and first published in 1997, this book has much that is relevant to Australian systems as a guide to home and small business installations. A practical guide to installation of telephone wiring, ranging from single extension sockets to PABX, with the necessary tools, test equipment and materials needed by installers.. 178 pages in soft cover.

$73

Microcontroller Projects in C for the 8051

by Dogan Ibrahim. Published 2000.

Through graded projects the author introduces the fundamentals of microelectronics, the 8051 family, programming in C and the use of a C compiler. The AT89C2051 is an economical chip with re-writable memory. Provides an interesting, enjoyable and easily mastered alternative to more theoretical text-

Servicing TV Satellite & Video Equipment. By Eugene Trundle. Revised edition 2002.

Written by a practising service engineer, the emphasis is on the practical business of fault diagnosis and repair, with chapters on TV power supplies, line timebases, video deck machines, test-gear, intermittent faults, repair techniques and workshop practice. This revised edition also features a completely new chapter on the latest digital equipment – DVD, set-top boxes, digital satellite TV and digital TV sets.

$70

NEW NEW NEW NEW

Practical Variable Speed Drives and Power Electronics

by Malcolm Barnes. 1st Ed, Feb 2003.

An essential reference for engineers and anyone who wishes to design or use variable speed drives for induction motors. As reviewed in SILICON CHIP September 2003.

$85

BOOKSHOP

ENQUIRING MINDS!

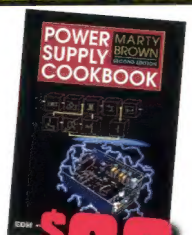
LOWER THAN RECOMMENDED RETAIL PRICE

10% OFF! WANT TO SAVE 10%? SILICON CHIP SUBSCRIBERS AUTOMATICALLY QUALIFY FOR A 10% DISCOUNT ON ALL BOOK PURCHASES!

Power Supply Cookbook

by Marty Brown. 2nd edition 2001.

An easy-to-follow, step-by-step design frame-work for a wide variety of power supplies. Any-one with a basic knowledge of electronics can create a very complicated power supply design . Magnetics, feedback loop, EMI/RFI control and compensation design are all described in simple language. 265 pages in paperback.

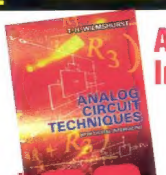


$99

Analog Cct Techniques With Digital Interfacing

by T H Wilmshurst. Published 2001.

Covers all the analog electronics needed in a wide range of higher education programs: first degrees in electronic engineering, experimental science course, MSc electronics and electronics units for HNDs. Text is supported by numerous worked examples and experimental exercises. 312 pages in paperback.



$69

VIDEO & CAMCORDER SERVICING AND TECHNOLOGY

by Steve Beeching (Published 2001)

Provides fully up-to-date coverage of the whole range of current home video equipment, analog and digital. Information for repair and trouble-shooting, with explanations of the technology of video equipment. 318 pages in soft cover.

$69

DVD PLAYERS AND DRIVES

by K.F. Ibrahim. Published 2003.

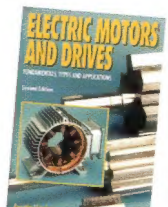
A guide to DVD technology and applications, with particular focus on design issues and pitfalls, maintenance and repair. Ideal for engineers, technicians, students of consumer electronics and sales and installation staff. As reviewed in Silicon Chip February 2004. 319 pages in paperback.

$79

Electric Motors And Drives

by Austin Hughes. 2nd edition 1993. Reprinted 2001.

For non-specialist users – explores most of the widely-used modern types of motor and drive, including conventional and brushless DC, induction, stepping, synchronous and reluctance motors. 339 pages, in paperback.



$63

Interfacing With C

by Howard Hutchings. Revised by Mike James. 2nd edition 2001.

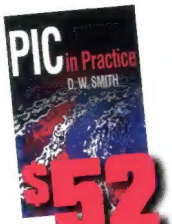
Anyone interested in ports, transducer interfacing, analog to digital conversion, convolution, filters or digital/analog conversion will benefit from reading this book. The principals precede the applications to provide genuine understanding and encourage further development. 302 pages in paperback.

$63

PIC IN PRACTICE

by D W Smith Published 2002

Based on popular short courses on the PIC, for professionals, students and teachers. Can be used at a variety of levels. An ideal introduction to the world of microcon-trollers for hobbyists, students and professionals. 255 pages in paperback.



$52

PRACTICAL RF HANDBOOK

by Ian Hickman 3rd Edition 2002

A guide to RF design for engineers, technicians, students and enthusiasts. Covers all of the key topics in RF: analog design principles, transmission lines, couplers, transformers, amplifiers, oscillators, modulation, transmitters and receivers, propagation & antennas. 279 pages in paperback.

$69

ORDER HERE

ANALOG CIRCUIT TECHNIQUES W/DIGITAL INT.	$69.00
ANALOG ELECTRONICS	$89.00
AUDIO ELECTRONICS	$92.00
AUDIO POWER AMPLIFIER DESIGN	$89.00
DVD PLAYERS AND DRIVES	$79.00
ELECTRIC MOTORS AND DRIVES	$63.00
EMC FOR PRODUCT DESIGNERS	$103.00
GUIDE TO TV & VIDEO TECHNOLOGY	$63.00
INTERFACING WITH C	$63.00
M'CONTROLLER PROJECTS IN C FOR 8051	$73.00
PIC IN PRACTICE	$52.00
PIC - YOUR PERSONAL INTRODUCTORY COURSE	$46.00
POWER SUPPLY COOKBOOK	$99.00
PRACTICAL RF HANDBOOK	$69.00
PRACT. VARIABLE SPEED DRIVES/POWER ELECT.	$85.00
SERVICING TV SATELLITE & VIDEO EQUIPMENT	$70.00
TELEPHONE INSTALLATION HANDBOOK	$69.00
UNDERSTANDING TELEPHONE ELECTRONICS	$70.00
VIDEO & CAMCORDER SERVICING/TECHNOLOGY	$69.00
VIDEO SCRAMBLING/DESCRAMBLING	$87.00

TAX INVOICE

Your Name _____
PLEASE PRINT

Address _____

_____ Postcode _____

STD

Daytime Phone No. (_____) _____

Email _____ @ _____

☐ Cheque/Money Order enclosed *OR*

Charge my credit card – ☐ Bankcard ☐ Visa Card ☐ MasterCard

No: ☐☐☐☐ ☐☐☐☐ ☐☐☐☐ ☐☐☐☐

Signature _____ Card expiry date ☐☐/☐☐

PLUS P&P (if applic): $..... TOTAL$ AU.....

P&P Orders over $100 P&P free in Australia.
AUST: Add $A5.50 per book
NZ: Add $A10 per book, $A15 elsewhere

POST TO: SILICON CHIP Publications, PO Box 139, Collaroy NSW, Australia 2097.
OR CALL (02) 9979 5644 & quote your credit card details; or **FAX TO** (02) 9979 6503

ALL TITLES SUBJECT TO AVAILABILITY. PRICES VALID FOR MONTH OF MAGAZINE ISSUE ONLY. ALL PRICES INCLUDE GST

SILICON CHIP'S

Electronic Projects For Cars Vol. Two

17 TOP CAR PROJECTS TO BUILD

IGNITION PROJECTS: High-Energy Universal Ignition System; High-Energy Multispark CDI System; Programmable Ignition Timing Module. **PIC-BASED PROJECTS:** Digital Speed Alarm & Speedometer; Digital Tachometer With LED Display; Digital Voltmeter (12V or 24V). **ALARMS & ENGINE MONITORS:** Blocked Filter Alarm; Simple Mixture Display For Fuel-Injected Cars; Motorbike Alarm; Headlight Reminder. **LIMITERS & IMMOBILISERS:** Engine Immobiliser Mk.2; Engine Rev Limiter. **MISCELLANEOUS:** 4-Channel UHF Remote Control; LED Lighting For Cars; The Booze Buster Breath Tester; Little Dynamite Subwoofer; Neon Tube Modulator.

ORDER DIRECT FROM SILICON CHIP PUBLICATIONS

Mail orders:	PO Box 139 Collaroy, NSW 2097
Phone Orders:	02) 9979 5644 (9-5, Mon-Fri)
Fax orders:	(02) 9979 6503 (24 hrs, 7 days)
Email orders:	silchip@siliconchip.com.au

Direct Order Prices:
Aust: $14.95 (incl. GST & P&P)
NZ/asia Pacific: $18.00 via airmail
Rest of World: $21.50 via airmail